Trade Logistics Quality and the Intra-African Trade of Agricultural Goods:

A Gravity Model Approach

by

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Declaration

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Abstract

Agriculture continues to be strategically important in Africa because of its contribution to gross domestic product and employment. Growth in the tradable and non-tradable segments of agriculture induce significant growth in other sectors through multiplier effects. Therefore, successful economic integration and poverty alleviation in Africa will remain linked to the liberalisation of the trade in agricultural goods (Cissokho et al., 2012). Africa's population is expanding and has a burgeoning middle class, particularly in urban centres. This is driving a growing demand for food and leading to changes in consumer preferences. Intra-African trade has not grown at the expected rate, considering the opportunity for trade across various product types, including agricultural goods. A number of studies, including those by Limão and Venables (2001), Portugal-Perez and Wilson (2012), Takele (2019) and Jordaan (2014), have shown that improved trade logistics can stimulate trade. There is limited literature on the impact of logistics on specific sectors and categories of goods or services within different geographies.

The objective of this study was to determine whether the improved trade logistics performance of an exporting and importing country influences intra-African trade in agricultural goods. This was explored through a comprehensive literature review and a gravity model augmented by the World Bank's Logistics Performance Index (LPI) scores as a proxy for trade logistics quality. A Poisson pseudo-maximum likelihood (PPML) regression was used to estimate the results of the gravity model, with a panel dataset of 38 countries, for 2010 to 2018.

The key results were that a 1% increase in the total agricultural exports of the partner country (supply) will lead to a 0.40% increase in the value of agricultural goods imported from that country by the reporting country; a 1% increase in the total agricultural goods imported by the reporting country (demand) will lead to a 0.82% increase in the value of agricultural goods imported by the reporting country from the partner country; when the importing country's currency is stronger than the exporting country's currency, the value of imports will be 14.11% higher than elsewise. Both the supply and demand variables were significant at the 1% level and the exchange rate dummy variable was significant at the 5% level. Although a scatter plot and correlation table indicated that the natural log of the average LPI of the importing and exporting country would have a positive relationship with the value of imports, the model's output indicated that the average LPI variable was not significant at the 10% level. One possible reason for the significance greater than 10% that is discussed is the idea that beyond a certain LPI score (level of trade logistics quality) little or no increase in trade will be generated due to improvements in trade logistics quality. In other words, maximum trade benefit is reached at an LPI score below the maximum score. Other considerations such as the time period of the data set and the aggregation of agricultural goods were also discussed. Additionally, the results raised questions about how to properly incorporate the effects of third-party transit countries' logistics quality in a gravity model, which has been recommended as a topic for further research.

Although the gravity model itself did not prove that the quality of trade logistics has a strictly positive influence on intra-African trade in agricultural goods, the literature review does support the argument that intra-African trade in agricultural goods can be stimulated by investment in the various components of African countries' trade logistics as well as in trade corridor initiatives.

Opsomming

Landbou is steeds van strategiese belang in Afrika vanweë die bydrae daarvan tot bruto binnelandse produk en indiensname. Groei in beide die verhandelbare en nie-verhandelbare segmente van die landbou lei tot noemenswaardige groei in ander sektore by wyse van vermenigvuldigereffekte. Suksesvolle ekonomiese integrasie en armoedeverligting in Afrika sal dus steeds sterk verband hou met die liberalisering van handel in landbougoedere (Cissokho et al., 2012). Afrika het ’n snelgroeiende bevolking en ’n ontluikende middelklas, veral in stedelike gebiede. Dít dryf ’n vinnig groeiende vraag na voedsel en lei na veranderinge in verbuikervoorkeure. Intra-Afrika handel het nie teen die verwagte koers gegroei nie gegewe die geleentheid vir handel oor verskeie produksoorte heen, insluitend landbougoedere. ’n Aantal studies, insluitend dié deur Limao en Venables (2001), Portugal-Perez en Wilson (2012), Takele (2019) en Jordaan (2014), het getoon dat verbeterde handelslogistiek handel kan stimuleer. Daar is beperkte literatuur oor die impak van logistiek op spesifieke sektore en kategorieë van goedere of dienste binne verskillende geografiese gebiede.

Die doelwit van hierdie studie was om te bepaal of die verbeterde handelslogistieke prestasie in ’n uitvoerende en/of invoerland ’n positiewe impak het op intra-Afrika handel in landbougoedere. Dít is verken by wyse van ’n omvattende oorsig van die literatuur, tesame met ’n swaartekragmodel wat ondersteun is deur die Wêreldbank se *Logistics Performance Index* (LPI) as ’n plaasvervanger veranderlike vir die gehalte van die betrokke logistieke stelsels. Die resultate van die swaartekragmodel is beraam deur gebruik te maak van ’n Poisson pseudo-maksimumaanneemlikheidsregressie (*pseudo-maximum likelihood regression)* (PPML), met ’n paneel-datastel van 38 lande vanaf 2010 tot 2018.

Die belangrikste resultate was dat 'n toename van 1% in die totale landbou uitvoere van die handelsvennoot (aanbod), sal lei tot 'n toename van 0.40% in die waarde van landbou invoere deur die rapporterende land vanaf die betrokke handelsvennoot; 'n toename van 1% in die totale ingevoerde landbouprodukte deur die rapporterende land (vraag), sal lei tot 'n toename van 0.82% in die waarde van landbougoedere ingevoer deur die rapporterende land vanaf sy handelsvennoot in Afrika; wanneer die geldeenheid van die invoerland sterker is as die geldeenheid van die land van uitvoer, sal die waarde van invoer 14,11% hoër wees as andersins. Beide die vraag- en aanbodveranderlikes was beduidend op die 1%-vlak en die wisselkoers fopveranderlike was betekenisvol op die 5%-vlak. Alhoewel 'n spreidiagram en korrelasietabel aangedui het dat die natuurlike log van die gemiddelde LPI van die invoer- en uitvoerland 'n positiewe verband sou hê met die waarde van invoer, het die produksie van die model aangedui dat die gemiddelde LPI-veranderlike nie op die 10%-vlak beduidend was nie.

Een moontlike rede vir die belangrikheid van meer as 10% wat bespreek word, is die idee dat verby 'n sekere LPI-telling (vlak van handelslogistieke kwaliteit) min of geen toename in handel gegenereer sal word as gevolg van verbeterings in die handelslogistieke kwaliteit nie. Met ander woorde, die maksimum handelsvoordeel word bereik met 'n LPI-telling onder die maksimum telling. Ander oorwegings soos die tydperk van die datastel en die samevoeging van landbougoedere is ook bespreek. Daarbenewens het die resultate aanleiding gegee tot vrae oor hoe om die effekte van die logistieke gehalte van derdeparty transito-lande in ’n swaartekragmodel in te sluit, wat voorgestel word as ’n onderwerp vir toekomstige navorsing. Hoewel die swaartekragmodel self nie bewys het dat die gehalte van handelslogistiek ’n streng

positiewe invloed op intra-Afrika handel in landbougoedere het nie, ondersteun die literatuuroorsig die argument dat intra-Afrika handel in landbougoedere gestimuleer kan word deur belegging in die verskeie komponente van Afrika-lande se logistiek sowel as handelskorridor-inisiatiewe.

This thesis is dedicated to

my Mother,

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Table of Contents

1. Introduction 1
1.1. Background to the Study 1
1.2. Problem Statement and Hypothesis 4
1.3. Research Objectives 4
1.4. Proposed Method 5
1.5. Outline of the Study 6
1.6. Conclusion 7
2. Regional Cross Border Trade 8
2.1. Introduction 8
2.2. International Trade Theory 8
2.2.1. A Brief Overview 8
2.2.2. Trade Balance and Terms of Trade 13
2.2.3. Trade Creation and Trade Diversion 13
2.3. African Trade 15
2.3.1. The Importance of Regional Integration 16
2.3.2. Regional Economic Communities and Preferential Trade Agreements 17
2.3.3. Trade Trends 22
2.4. How is the Trade of Agricultural Goods Different to Other Goods? 31
2.4.1. Seasonality Considerations 31
2.4.2. Perishability 31
2.4.3. Reliance on Climate 32
2.5. Factors that Influence Trade 33
2.5.1. Costs 33
2.5.2. Trade Logistics and Transport Costs 33
2.5.3. Tariffs and Trade Agreements 34
2.5.4. Time and Distance 35
2.5.5. Standards 36
2.5.6. Customs 37
2.5.7. Demand and Consumer Preferences / Trade Complementarity 38
2.5.8. Local Production 39
2.5.9. Cultural and Social Similarities 39
2.5.10. Institutional Quality, Political Stability and Governance 39
2.5.11. COVID-19 Pandemic 40
2.6. Conclusion 41
3. Trade Logistics 44
3.1. Introduction 44
3.2. The Definition and Role of Trade Logistics 44
3.3. The African Context 47
3.3.1. Background 47
3.3.2. Trade Corridors 48
3.3.3. Transportation Modes and Infrastructure 50
3.3.4. Customs Environment 60
3.3.5. Investment 62
3.4. Measures of Trade Logistics Quality 64
3.4.1. Global Competitiveness Index 64
3.4.2. The World Bank's Ease of Doing Business: Trading across borders 66
3.4.3. Logistics Performance Index 67

3.5. Conclusion 69
4. A Theoretical Discussion of Gravity Models 71
4.1. Introduction 71
4.2. Theory 71
4.3. A Brief Note on the 'Distance Puzzle' 74
4.4. Challenges and Potential Estimation Problems 75
4.5. Estimation Methods 77
4.6. Augmented Gravity Models 80
4.7. Aggregated and Disaggregated Trade Data 83
4.8. Conclusion 84
5. The Practical Application of the Gravity Model 85
5.1. Introduction 85
5.2. Hypothesis 85
5.3. Building the Database 85
5.4. Choice of Estimation Method 88
5.5. Model Specification and Expectations 88
5.6. Conclusion 94
6. Model Results 95
6.1. Introduction 95
6.2. Summary of Descriptive Statistics for the Gravity Variables 95
6.3. The Model Results 96
6.4. Interpretation of the Model Results 97
6.5. Discussion 100
6.6. Conclusion 104
7. Conclusion 105
7.1. Introduction 105
7.2. Summary of Findings 105
7.3. Practical Implications 106
7.4. Policy and Research Recommendations 107
7.5. Conclusion 108
8. References 109
9. Appendix 124
9.1. Tables 124
9.2. Figures 126

List of Tables

Table 2-1 Stages of Economic Integration 15
Table 2-2 Regional Economic Community Membership 18
Table 2-3 Regional Economic Community Preferential Trade Agreements 20
Table 2-4 Regional Agricultural Goods Export Value and Percentage of which was Intra-Regional Exports 24
Table 2-5 Regional Import Value Agricultural Goods and Percentage of which was Intra-Regional Imports 24
Table 2-6 African Countries Most Involved in Intra-African Trade by Value in 2018 26
Table 2-7 African Countries Most Involved in Trade by Value in 2018 27
Table 2-8 The Largest Intra-African Agricultural Imports of 2018 by Value and their Import Percentage Relative to Total Imports 29
Table 3-1 Overland Trip from South Africa to Nigeria (Shortest Route by Distance) 58
Table 3-2 Regional Performance by Pillar (Average Score 0-100) 65
Table 3-3 The Highest Scoring African Countries for Overall LPI in 2018 68
Table 3-4 Top Scoring African Countries for International LPI Components in 2018 68
Table 4-1 Summary of Available Estimation Methods 79
Table 4-2 Summary of Selected Studies that use a Gravity Model 80
Table 5-1 Summary of Variables Chosen for Inclusion in the Gravity Model 91
Table 5-2 Predictions for Independent Variables Coefficients 93
Table 6-1 Variable Names used in STATA and Corresponding Variable Names from Table 5-1 95
Table 6-2 Summary of Descriptive Statistics for Non-dummy Variables 96
Table 6-3 Estimation Outputs 97
Table 6-4 Interpretation of the Coefficients 99
Table 6-5 Correlations 101
Table 9-1 Elasticities by Food Category in East and Southern Africa 124
Table 9-2 African Countries included in the Study Sample 124
Table 9-3 HS Chapters Defined as Agricultural Goods 125
Table 9-4 Results for GDP PPML FE Model 125

List of Figures

Figure 2-1 Intra-Continental Imports of All Products as a Percentage of Total Imports 2001-2018 (All Goods) 23
Figure 2-2 Intra-Continental Exports of All Products as a Percentage of Total Exports 2001-2018 (All Goods) 23
Figure 2-3 The Percentage of African Imports that came from other African Countries 2001-2018 25
Figure 2-4 The Value of Intra-African Imports 2001-2018 25
Figure 2-5 The High-Level Split between African Agricultural Goods Export Markets 27
Figure 2-6 The Change in the Share of World Agricultural Exports: The Top 5 Gainers and Losers in the Share of Exports of Agricultural Goods by Value from 2001-2018 28
Figure 2-7 Typical Maize Trade Flows in Southern and East Africa 30
Figure 3-1 Links between an Enhanced Logistics Chain and Economic Growth 45
Figure 3-2 The Typical Export Process 46
Figure 3-3 Transport and Insurance Costs as a Percentage of Trade Value 48
Figure 3-4 Diagram of Trade Corridors in East, West and Southern Africa 50
Figure 3-5 The Link between Transport Infrastructure and Trade Volumes 54
Figure 3-6 The Trans-African Highway Network 57
Figure 3-7 Percentage Year on year Growth in International Freight Tonne Kilometres by Region 60
Figure 3-8 The Time Taken to Complete Border and Documentary Compliance in Different Regions in 2020 61
Figure 3-9 The Costs for Border and Documentary Compliance in Different Regions in 2020 61
Figure 3-10 Sources of Investment for African Infrastructure in 2017 63
Figure 3-11 Regional Trading across Borders Score for 2020 66
Figure 3-12 Overperforming and Underperforming Countries 67
Figure 6-1 Scatter plot of Imports and the natural log of average LPI 102
Figure 9-1 Scatter plot of Imports (USD thousands) and the natural log of Distance between the Exporter and Importer 126
Figure 9-2 Scatter plot of Imports (USD thousands) and the natural log of the Demand of the Importer 126
Figure 9-3 Scatter plot of Imports (USD thousands) and the natural log of the Supply of the Exporter 127
Figure 9-4 Scatter plot of Imports (USD thousands) and the natural log of the Exporter's LPI 127
Figure 9-5 Scatter plot of Imports (USD thousands) and the natural log of the Importer's LPI 128

List of Equations

Equation 2-1 13
Equation 2-2 13
Equation 4-1 72
Equation 4-2 72
Equation 4-3 72
Equation 4-4 73
Equation 4-5 78
Equation 5-1 91
Equation 6-1 98
Equation 6-2 98

List of Abbreviations and Acronyms

AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
AMU	Arab Maghreb Union
AU	African Union
CEN-SAD	The Community of Sahel-Saharan States
COMESA	The Common Markets for Eastern and Southern Africa
EAC	East African Community
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EU	European Union
FAO	Food and Agricultural Organisation of the United Nations
FE	Fixed Effects
FTK	Freight tonne kilometres
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
HS	Harmonised System
HSS	Heckman Sample Selection
H-O	Heckscher-Ohlin
HVP	High Value Product
IATA	The International Air Transport Association
ICT	Information and communications technology
IGAD	Inter-governmental Authority on Development
IMF	International Monetary Fund
ITC	International Trade Centre
LPI	Logistics Performance Index
MENA	Middle East and North Africa
NTB	Non-tariff barrier
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least squares
PPML	Poisson Pseudo-Maximum Likelihood
RE	Random Effects
REC	Regional Economic Community
SADC	Southern African Development Community
STATA	StataCorp's statistics and data software
TEU	Twenty-foot equivalent units
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
USA	United States of America
USD	United States Dollar

1. Introduction

1.1. Background to the Study

Africa is a vast continent of 54 countries, which cover an expanse of 30 million km^2. The process of structural transformation has occurred in a highly variable manner across Africa. Countries' economies continue to develop at differing rates based on the presence or lack of numerous drivers. These drivers include foreign and local investment; employment through non-farm informal rural activities; governance and reformative policies; global commodity prices; and growth in agriculture (Jayne et al., 2018). Agriculture continues to hold a place of strategic importance in many African countries due to its contribution to gross domestic product (GDP) and employment. Agricultural productivity (net productivity per capita) has important implications for industrial development and in turn structural transformation (Sandrey, 2018). Agriculture is still a major contributor to gross domestic product (GDP) in many African countries; contributions were still as high as 60% for Sierra Leone and Somalia in 2016, according to the Economic Commission for Africa et al. (2019). GDP per capita, a measure of poverty, is lower in Africa than any other region of the world (IMF, 2019). The ability of a sector to reduce poverty is dependent on that sector's growth performance; its indirect influence on the growth of other sectors; the number of people employed in the sector; and the size of the sector relative to the total economy (Christiaensen, 2017). Growth in both the tradable and non-tradeable segments of agriculture can induce significant growth in other sectors of the economy, downstream and upstream through multiplier effects. Christiaensen et al. (2011) determined using a cross-country econometric model that within the African context, the agricultural sector is significantly more effective at alleviating poverty than other sectors. Successful economic integration and poverty alleviation in Africa is therefore likely to remain strongly linked to the liberalization of trade of agricultural goods (Cissokho et al., 2012).

There is a 6 million km^2 expanse of grassland stretching from Senegal to South Africa. Some 4 million km^2, 66% of this land, is suitable for farming but as of 2009 only 600 thousand km^2 were cropped according to the FAO (2009). The reality is that much of this 3.4 million km^2 of uncropped land is unusable due to active conflict and pre-existing conservation areas or it is inaccessible for agricultural activities due to insufficient transport infrastructure. A 2019 report from McKinsey & Company suggests that around 200 000-300 000 km^2 of land in Africa actually has the potential to accommodate the expansion of agriculture (Goedde et al., 2019). This suitable land is spread across nine countries, but should all of it be converted to under crop, it could increase Africa's total cultivated land by 10%. Agricultural growth in Africa is going to continually become more reliant on increasing productivity and expansion through intensive farming as opposed to extensive expansion through increased area usage (Jayne et al., 2018). Africa has the potential capacity to produce enough food to be self-sustaining as well as to use agricultural exports to drive economic growth. Change on the African continent may only be incipient, but there is an opportunity for a growth strategy whereby agriculture-based economies can be centred around the agricultural sector and its exports. Increased exports by Africa both intra-regionally and inter-regionally should help Africa become more competitive in the global market through scale efficiencies; economy diversification; reducing inflationary effects; and countering poverty through job creation (Botes et al., 2018).

As Moïsé et al. (2013) put it so succinctly: “trade can be a powerful engine for economic growth, poverty reduction, and development”. Globalization and trade create broader markets, which generate opportunities for industries to exploit large scale production and better allocate their resources. A beneficial by-product of tradable agriculture is the foreign exchange that it brings into the exporting country, which leads to economic growth (The World Bank, 2008). Foreign exchange provides the exporting country with the means to import capital goods and inputs for industry. African countries that are rich in natural resources, such as the oil exporters, are less dependent on agriculture as an earner of foreign exchange than other African countries. Imports can decrease the cost of inputs for producers and cheaper inputs allow producers to produce more product and increase their profitability. Imports also give consumers access to a greater variety of goods. This allows the consumer the choice to consume products that would not typically be produced in their local market. Most importantly trade creates an environment in which countries can leverage off their comparative advantage and specialize in the production and export of certain goods and services to increase welfare. In lesser developed countries, it can be more challenging to fully harness the ‘power’ of trade liberalization, as these countries typically face supply-side constraints such as poor transport infrastructure and obstacles to higher productive capacity such as access to only low yielding crop cultivars.

Agricultural trade is a small proportion of total global trade by value. In 2018, agricultural imports made up 7% of total world imports (ITC, 2020), but despite this low proportion, global food trade has seen sharp rapid increases in nominal terms from 2001 through to 2018. These increases can be attributed to urbanization, population growth and an enlarging middle-class in developing countries - all of which are drivers of food demand (Bamber et al., 2014). Africa in particular has a rapidly increasing population and a burgeoning middle class, especially evident in urban centres. From 2000-2017, the rapid growth of the African population has led to increased demand for food and has put pressure on the existing farming systems (Binswanger-Mkhize & Savastano, 2017). In conjunction with this, continued urbanisation and economic growth have created more opportunities and larger markets for the agricultural sector within Africa itself. As of 2010, 35% of Africa’s population formed part of the middle class (Tschirley et al., 2015). On a percentage basis this is up from 27% in 1980 but on an actual value basis the middle class has grown from 126 million to 350 million people. Urbanisation is becoming prevalent, as more people migrate from rural areas into expanding urban agglomerations. As of 2018, 40% of the total population in Africa was already living in an urban area (The World Bank, 2019). While some countries such as Sao Tome and Principe are highly urbanised with an urban population of 73%, other countries such as Burundi, Niger, Malawi and Rwanda have urban populations of less than 20% (The World Bank, 2019). This statistic demonstrates that although urbanisation is increasing in many parts of the subcontinent, there are countries that have not yet begun to see the trend take hold, which highlights the fact that African countries are not all in the same stage of structural transformation.

Across the African continent, mega-cities (urban agglomerations of more than 10 million people) are starting to emerge in countries where urbanisation and a mushrooming population have combined. Examples of already existing mega-cities are Lagos and Kinshasa (UN, 2018). These mega-cities are hubs for transport, business and finance and are a source of an ever-growing demand for food. Walther et al. (2020) observe that cities need to be well connected to transport networks in order to successfully act as markets for domestic agricultural produce and regional hubs for trade. The mounting concentration of demand for food in megacities raises the question of how to feed these urban populations; either more food needs to be imported or more food needs to be produced domestically and then transported to where the demand is based.

A growing middle class relative to other classes means that moving forward, overall consumer preferences in most African food markets will largely be influenced by the consumption habits of the middle class. These overarching preferences will be drivers of the future African food economy. The rise of the African urban middle class could stimulate consumer spending to increase by USD 645 billion between 2015 and 2025. USD 167 billion of that will be spent on food and beverages - the majority of which is expected to come from African countries. The African middle class purchases 61%-83% of their food, as opposed to farming their own food and 70-80% of this food expenditure is on processed food (Tschirley et al., 2015). In Tschirley et al. (2015), the authors investigate expenditure elasticities for different levels of processed foods in East and Southern Africa – see Table 9-1 in the Appendix. In East and Southern Africa, perishable foods have a higher expenditure elasticity than non-perishable food groups – this applies to both the urban and rural populations. As people in these regions spend more money on food so the proportion spent on perishable foods will increase. The food category with the highest expenditure elasticity is perishable high value-added processed food (Tschirley et al., 2015). Examples of this category include dairy and ready-made meals. It is predicted that African urban consumers will demand more fresh produce, as well as dairy, meat and processed foods. Increased demand is going to be a challenge for the African food system but can be converted into an opportunity. Some agricultural goods, such as rice will need to be imported from outside of Africa to meet demand, but other agricultural crops can be produced on the continent and then traded intra-regionally.

Intra-African trade has thus far not grown at the rate that would be expected considering the opportunity for trade across various product types, especially agricultural goods. Donaldson (2019) was able to establish a strong association between the introduction of railroads to districts in colonial India and an increase in total agricultural income, which could be linked to increased trade of agricultural goods with other districts. Arvis et al. (2012) and Limão and Venables (2001), amongst others, have also shown a positive relationship between improving transport and logistics and volume of trade. Botasso et al. (2018) explain that transport infrastructure, regional connectivity and international freight flows are all linked to each other.

Agricultural products are one of the opportunities for intra-African trade that has thus far been underexploited. As was evidenced by the Tschirley et al.'s (2015) study, consumers choose to spend more of their income on perishable goods as their food expenditure increases. Perishable food demand is typically serviced by the local market, as fast reliable transport of perishable foods over borders can be expensive, especially in Africa which has relatively low-quality trade logistics in place. For this reason, there may be increased sensitivity to trade logistics for trade flows of agricultural goods between African countries. This means improving domestic logistics quality in combination with vertical integration of supply chains could to some extent open up trade channels allowing consumers a wider choice of agricultural goods both perishable and non-perishable. Quality logistics services and systems enable the reliable and fast movement of goods at lower costs from one country to another. Increased competitiveness in global trade has therefore resulted in a growing importance for efficient logistics for producers to stay relevant to the rest of the market (Marti et al., 2014). Improved logistics quality in neighbouring countries will likely reduce the cost of food imports, particularly for landlocked countries, as a supply chain is only as strong as its weakest link.

A number of studies including Portugal-Perez and Wilson (2012), Takele (2019) and Jordaan (2014) have shown that improved trade logistics can stimulate trade. There is, however a

limitation to the available literature with regard to the impact of trade logistics on specific sectors and categories of goods or services. Saslavsky and Shepherd (2012) mention that the existing sector specific trade literature does not necessarily focus on sectors that are particularly sensitive to the quality of trade logistics. This makes it relevant to investigate whether the intra-African trade of agricultural goods can be increased through improved trade logistics quality. This study will focus chiefly on the linkage between trade logistics and the cross-border trade of agricultural goods within Africa.

1.2. Problem Statement and Hypothesis

The problem is that Africa is currently not reaching its full potential for intra-regional trade, particularly with regard to agricultural goods. The question is how can this be overcome?

Literature, including the studies of Bottasso et al. (2018), Marti et al. (2014), Takele (2019), Bensassi et al. (2015), Christ and Ferrantino (2011), Portugal-Perez and Wilson (2012) and Freund and Rocha (2010), all suggest that improvements in trade facilitation and trade logistics should lead to increased trade between countries, as a result of decreased cost and increased reliability of delivery of goods. Agricultural goods can be perishable in nature and therefore the time it takes to transport the goods has ramifications on the quality of the goods and therefore their trade-ability and profitability. Consequently, it would make sense that trade logistics has an even larger impact on the trade of agricultural goods than other non-time sensitive categories of goods. It is suspected that poor trade logistics is one of the main factors inhibiting growth in intra-African trade so this is a point in the system where investigation could be key.

The level of trade supporting infrastructure and transport efficiency in Africa, as outlined in Chapter 3, is relatively low compared to other regions around the world. Portugal-Perez and Wilson's (2012) findings show that the marginal effect of transport efficiency and the business environment on exports decreases as a country's income per capita increases, whereas the marginal effect of physical infrastructure and information and communication technologies on exports increases as GDP per capita increases. Based on these findings it would be logical to assume that logistics quality should have a substantial impact on trade in Africa, where most countries have relatively low GDP per capita compared to other regions around the world (IMF, 2019).

The hypothesis for this study is that the level of trade of agricultural goods amongst African countries increases when the logistical quality of the exporting and importing countries increases.

1.3. Research Objectives

The aim of this study is to determine the degree of influence that the logistical quality of the importer country and exporter country has on the intra-African trade of agricultural products.

The main objective of the study is to determine whether the improved trade logistics performance of exporting and importing African country trading partners positively impacts the trade of agricultural goods. The main objective will be achieved by completing the below list of supporting objectives.

- Determine whether the available literature supports the hypothesis.
- Develop a gravity model that will test the hypothesis.

The paper's overall purpose is to assess the role that trade logistics currently plays with respect to agricultural trade within the African continent, as well as to look at the implications of improved trade logistics and transport infrastructure quality for future trade.

1.4. Proposed Method

The research objectives will be achieved through a comprehensive review of the relevant literature in conjunction with the estimation of a gravity model. The study will begin by reviewing both the theory behind international trade and the context around intra-African trade, as well as the factors that have an influence on the trade of agricultural goods. The review of the available literature will then turn to trade logistics quality and will cover the definition and role of trade logistics within the African context. A key part of this will be identifying the various available measures of trade logistics quality.

As is discussed in Chapter 4, the gravity model is a well-established econometric model which has been theoretically and empirically validated. The primary use of the gravity model is to measure bilateral trade flows and determine patterns of trade. It is a relatively easy to use model and has limited data requirements, thus making it the model of choice for this study.

The gravity model will include an independent variable for the logistics quality of the exporting country and an independent variable for the logistics quality of the importing country. Trade logistics encompasses the management, organisation and physical movement of goods from one place to another. The World Bank's international Logistics Performance Index (LPI) data will be used for the values for both of these variables. The international LPI is a biennially produced global benchmark for over 160 countries and is comprised of 6 indicators: border control agencies; infrastructure; pricing of shipments; tracking and tracing ability; timeliness; and quality of logistics services. The international LPI is generated from a global survey of operators such as international freight forwarders and express carriers, who provide feedback on the logistics 'friendliness' of the countries in which they operate.

A time period of 10 years, 2010-2018, is considered in the gravity model. The period has been chosen to align with the data that is available for logistics quality– this data is updated every two years by the World Bank. Data for five years (2010, 2012, 2014, 2016 and 2018) is used in the gravity model. The LPI is only available for one additional year, which is 2007, which was not included in the model's dataset due to the three-year time gap between measurements, which is not congruent with the rest of the time gaps between measurements.

The focus of the study is on intra-African trade. All 54 African countries were initially considered but the eventual sample contained 38 African countries as trading partners for the gravity model. The 38 countries were selected purely based on data availability. Sudan and South Sudan were excluded on the basis that there have been changes in political boundaries during the last 10 years and as such trade data is not necessarily comparable over a time series. The countries that were used in the sample are listed in Table 9-2 in the Appendix.

The study only considers the trade of agricultural goods, which are goods that originate from crops or animals. Tobacco products as well as agricultural products not fit for human consumption were excluded from the dataset. Agriculture is going to be a crucial part of Africa's future development, especially considering the growing demand and changing consumer preferences for food on the continent. For the purpose of this study, agricultural goods have been defined as the Harmonized System (HS) chapters included in Table 9-3 in the Appendix. The decision was taken to work at an HS Code Level 2 in order to reduce unnecessary complexity. It was taken into consideration that different categories of agricultural goods may have differing levels of sensitivity to trade logistics quality. However, out of concern that African trade data is already quite "thinly" available it was decided to work with a larger group of agricultural products rather than disaggregating them into bulk goods, perishable goods and other categories. The narrowing of the category of agricultural products would have undoubtedly reduced the number of observations and thus the sample size available for the gravity model.

1.5. Outline of the Study

Chapter 1's core aim is to build the foundation for the rest of the study. Firstly, background information is provided to give context to the study, the problem statement, the hypothesis and the research objectives. The proposed method for proving or disproving the hypothesis is then given. The last section of the Chapter is a roadmap for the rest of the study and it gives guidance as to what content each Chapter contains.

Chapter 2 begins by addressing basic international trade theory and explains why firms in different countries choose to trade with each other. The Chapter then stresses the importance of regional integration and establishes why it is valuable to increase intra-African trade. The regional economic communities and existing trade agreements are listed and briefly considered in terms of their contributions to intra-African trade. The chapter then delves into the African trade trends that have developed over the last 10-20 years and the nuances of the trade of agricultural goods. The Chapter closes out by examining the factors that influence trade in order to build an understanding of why logistics quality and transport infrastructure are relevant to the intra-African trade of agricultural goods.

Chapter 3 starts by introducing the role that trade logistics plays in trade and regional integration. The African context is then put forth and the sub-section covers in detail the current state of trade logistics and investment therein. The Chapter concludes by discussing three of the available measures of logistics performance and infrastructure quality. This a key chapter in the study as it highlights the relevance of trade logistics in African trade.

Chapter 4 is a literature review of gravity models. The history and concept of the gravity model is explained. This is followed by a brief note on the 'distance puzzle'. Importantly, the common challenges encountered with gravity models are discussed and considered before the various methods of estimation for gravity models and their advantages and disadvantages are debated. A select sample of studies that have used gravity models that have been augmented with infrastructure variables are reviewed. The final sub-section of this chapter looks at the use of aggregated and disaggregated data in gravity models and the optimal proxy variables the different datasets.

Chapter 5 provides an overview of the practical application of the gravity model for this study. This incorporates details on the building of the database, the specification of the gravity model, the reasoning behind the selection of variables and a description of the expected outcomes.

Chapter 6 describes the dataset and presents the results of the gravity model estimations. An interpretation of the model outputs is provided, and a conclusion is drawn based on this and other supporting information, as to whether trade logistics quality influences the intra-African trade of agricultural goods.

Chapter 7 highlights the research findings of this study and discusses the implications thereof. This final chapter is closed out with recommendations for policy makers as well as suggestions for future research.

1.6. Conclusion

Chapter 1 provided a backdrop for the study. The background established that there is scope for a study that looks specifically at the influence of trade logistics quality on the trade of agricultural goods within Africa. African countries have the lowest GDP per capital globally and are not fulfilling their trade potential, which is disappointing as trade has the capacity to drive development and economic growth. The question that arises is, what is inhibiting trade amongst African countries? This brings one to the problem statement and hypothesis that centre around trade logistics quality and its possible influence on the intra-African trade of agricultural goods.

The objectives of the study were clearly defined. The main objective of the study is to determine whether the quality of trade logistics impacts the intra-African trade of agricultural goods. The proposed methodology was then run through to establish the direction of the study and the manner in which the author plans to complete the research objectives and prove the hypothesis. The key variable in the gravity model will be the average LPI score of the importing and exporting country pair.

An overview of the study was given to create a roadmap for the rest of the paper and to give general context. The relevance of this study is that its outcome will enable policy makers to make better informed decisions around components of trade logistics, when considering how to increase or improve the efficiency of intra-African trade of agricultural goods.

The next chapter will dive into regional cross border trade, beginning with international trade theory, then go on to examine the various regional economic communities and free trade areas in Africa. The chapter will then progress to look at the existing trade trends and the characteristics of agricultural trade, before closing out by discussing the factors that influence trade. The next chapter is important in ensuring that the reader has a reasonable understanding of the basics of international trade and current state of trade in Africa.

2. Regional Cross Border Trade

2.1. Introduction

Chapter 2 begins by providing a review of international trade theory. The Chapter then establishes the importance of regional integration and increasing Africa's intra-regional trade, before progressing to add context by presenting the existing trade framework and regional agreements present in Africa. The current state of intra-African trade is outlined and illustrated through various graphs and tables that present existing trends. Following which, the various factors that influence trade volumes are listed and briefly described. The last sub section of the Chapter outlines the unique characteristics of agricultural goods in order to understand how trade of this category of goods may differ from trade of other categories of goods. The purpose of this Chapter is to understand why international trade takes place and what factors influence the volume of trade between countries, particularly in Africa. This is important to understand, as it will form part of the basis of the model discussed in Chapter 5 and Chapter 6.

2.2. International Trade Theory

International trade in its simplest form is the exchange of goods and services between firms in different countries. International trade theory attempts to explain why international trade takes place.

2.2.1. A Brief Overview

International trade theory can be broadly split into two themes, classical country-based theory and modern firm-based theory. This overview begins by concentrating on the former theme of trade theory.

Western European economics during the sixteenth to the late eighteenth centuries was characterized by mercantilism. Mercantilism is the economic theory that the more wealth a country accumulates the better. This theory brought a widespread belief that countries should export as many goods as possible, whilst limiting imports, thus resulting in a trade surplus and net income gain of gold and silver. Behaviours associated with this line of thought include government intervention to protect domestic industries and subsidise export industries, the stockpiling of gold and the increased restriction of imports through tariffs. There are negative connotations around mercantile behaviour, as it works on a zero-sum game basis, where a party can only benefit at the expense of another party. David Hume, a Scottish philosopher, developed an empirical argument against mercantilism, where he theorised that prices in the home country change as money supply changes. Hume showed that the increase in domestic prices due to the gold inflow would discourage exports and encourage imports, thus automatically limiting the amount by which exports would exceed imports. Hume's work is believed to have had a significant influence on Adam Smith, although Smith did not use Hume's arguments to bolster his own. Adam Smith wrote "The Wealth of Nations", wherein he discussed markets, production and economic theory. Smith critiqued mercantilism, which he lambasted for its lack of theoretical underpinning and the selfish behaviour that it encouraged. Smith then went on to outline the benefits of free trade. He was an

advocate of free trade, during a period when trade was largely restricted and countries were focused on protecting their domestic producers. Smith explained the occurrence of trade using the concept of absolute advantage. Absolute advantage is the ability of a country to produce a good or service at a lower cost than another country. These differences in costs are explained by differing levels of natural endowments and acquired human capital across countries (Myint, 1977). Smith through “The Wealth of Nations” was able to initiate discussions around efficient resource allocation as a benefit of trade. This proved to be a hugely influential paper for the major contributions to economic theory that followed over the next century. Smith suggested that national trade borders are more prohibitive to trade than would be logically expected, but the reasons behind this would be investigated by the economists that followed.

Traditionally established gains from trade include improved efficiency of resource allocation, the reduced control of monopolies, and increased variety of goods available for consumers (Gray, 1986). David Ricardo expanded on Smith’s ideas by introducing the concept of comparative advantage. The theory of comparative advantage is central to the neoclassical branch of economic theory (Costinot et al., 2015). The Ricardian model of comparative advantage assumes that trade is driven by technology and productivity differences between countries. The model involves two goods and one factor, which is perfectly mobile between industries but is immobile between countries. Comparative advantage is the ability of a country to produce a good or service at a lower opportunity cost than another country. The Ricardian model is essentially able to explain why a country would trade even if it had the absolute advantage in both goods. Ricardo’s most famous example is that of England and Portugal as clothing and wine producers. Ricardo predicts that both countries will completely specialize in the production of a single good. Specialization results in a more efficient allocation of resources, thus increasing net welfare. The opportunity cost is indicative of what a country sacrifices, if it produces one good over another. A single country in the example can have the absolute advantage in producing both goods, but the good with the smaller ratio is the good that the country should be producing. In effect, a country should export those goods in which it is an efficient producer and should import goods that it cannot produce efficiently. The largely unanswered question relating to comparative advantage is how should nations use this information to design their trade policy. Is it better to protect import sectors that have weaker comparative advantage, relatively more? Do export sectors with relatively strong comparative advantage require relatively lower subsidies? Costinot et al. (2015) attempt to answer precisely this question; the authors found that in the context of a canonical Ricardian model, it is optimal for import tariffs to be kept uniform, whereas export subsidies should gradually decrease as the relative comparative advantage of a sector increases. This is an indication that countries have more scope to manipulate the prices of those sectors in which they have a comparative advantage (Costinot et al., 2015). The national income of a country can be increased through policies that encourage the production of goods in which that country has a comparative advantage (Nakhumwa et al., 1999). Ricardo’s theory of comparative advantage fundamentally differs from mercantilism, as through it both countries benefit from the trade of goods, allowing for more of everything to be produced than if there was little or no trade. When both countries specialize in production and focus on what they can produce most efficiently in relative terms then in theory everyone should benefit. The neo-classical branch of economics has since grown to incorporate the concepts of free markets and private property.

The Heckscher-Ohlin model, also known as factor proportions theory, endeavours to explain the existence of comparative advantage (Bahta & Jooste, 2005). The Heckscher-Ohlin model involves two goods, two factors and two countries. The model states that there are no

technological differences between the two countries, but that there are differences in the factor endowments across the two countries. The two goods differ in their intensity of use of the two factors, when produced. The Heckscher-Ohlin model states that each country will choose to produce and export the good that has a more intensive usage of that country's most abundant factor. In other words, patterns of comparative advantage result from relative factor abundance patterns across countries (Cingano & Pinotti, 2016).

The Heckscher-Ohlin model is comprised of four sub-theories (Markusen et al., 1995):

1. A country has a comparative advantage in the good, which most intensively uses that country's most abundant factor.
2. Factor-Price Equalization theory: free trade equalizes factor rewards between countries and acts as a substitute for cross border factor mobility.
3. Stolper Samuelson theory implies that an increase in the relative price of a good will increase the return of the factor that is used intensively in the production of that good. Concurrently this reduces the return of the other factor, in real terms.
4. Rybcynski theory: when the coefficients of production are fixed and the supply of factors are completely used up, then an increase in the endowment of one factor of production will increase the output of the good that uses that factor most intensively and reduces the output of the other good.

Critics of the Heckscher-Ohlin model argue that it provides an inadequate explanation for trade patterns, as it doesn't allow for the technological differences that clearly do exist across countries (Feenstra, 2003). The Leontief paradox was first encountered by Wassily Leontief in 1947, following a test of the Heckscher-Ohlin model. The intention of the test was to uncover the factor proportions structure of the United States of America. At this point in time, the United States of America was widely recognized to be the most capital abundant country in the world. Leontief therefore expected to find that that United States would be exporting capital intensive goods and importing labour intensive goods. This proved not to be the case and the data showed the opposite trend; the United States of America was importing relatively capital-intensive goods and exporting relatively labour-intensive goods. This result was paradoxical to the predictions of the Heckscher-Ohlin model and was thus coined as the 'Leontief Paradox'. Later, explanations were developed to explain Leontief's surprising results. The most convincing explanation was that the labour measurement units used by Leontief may have skewed his results, as the efficiency and productivity of workers in the different countries were not considered. Additionally, Leontief's test did not take natural resources into account.

Ricardo's contributions to international trade theory were chronologically followed by the communist line of thought from Karl Marx and Friedrich Engels in the 1840's. Marx and Engels chose to look at economic classes rather than individuals and established that conflict between workers and property owners was likely to occur. Their thinking challenged that of Smith's, by suggesting that collective ownership as opposed to private ownership of property is best for overall welfare. Communism and free market capitalism fall on different ends of the political spectrum. Free market capitalism continued to dominate into the late 19th century, while communism slowly grew its own following. The free market capitalism supporting theories of Smith and Ricardo became known as classical economics. Alfred Marshall published a book called the 'Principles of Economics' in 1890. Marshall's book looked at the concepts of supply and demand and marginal utility. The great economic depression of the 1930's largely impacted countries operating with free markets. The classical economic theory of Smith and Ricardo did not provide any solutions on how to deal with the crash of free markets. John Maynard Keynes

came to the fore with his proposed theories of 'spending' to regenerate the capitalist free markets. He had three core principles to his economic theory: aggregate demand is the most important driving force in an economy and can be influenced both by the public and private sectors; prices and wages change gradually in response to adjustments of supply and demand; changes in aggregate demand impact real output and employment more than prices in the short run (Jahan et al., 2014). Keynes published two books in the 1930's which had a substantial influence on economic thought at the time. Keynes was largely responsible for the rise of the field of macro-economics and John Hicks was another early contributor. Both men argued that free market economies cannot rebalance quickly because both prices and wages take time to adjust to changes in demand and supply. Their view was that during a time of recession, it is necessary for the state to get involved and use monetary and fiscal policy to increase production output and to decrease unemployment. Keynes and Hicks were not supporters of Marxist lines of thought or communism but they did challenge the classical economic view that the government should never interfere in the market. Keynesian economics became a part of mainstream economic theory and remained popular until the 1970's (Jahan et al., 2014).

Friedrich Hayek and Ludwig Vonmises are the two economists synonymously associated with the Austrian School of Economics, a branch of economic theory that was largely in opposition to Keynesian economics during the 1920's and 1930's (Oppers, 2002; Jahan et al., 2014). The Austrian School of Economics believes that economic declines and booms are part of the business cycle and that state involvement will not aid the recovery of depressed economies. This school of thought promotes free markets and private property ownership. Hayek and Vonmises argued that heavy state involvement had never produced the outcomes that it promised - regulation and government interference is seen to be a major stumbling block by the Austrian school of economics. Intrinsically, supporters of this economic theory believe that the economy of a country is too complicated to manipulate in a precise manner, without causing undue harm.

In the 1970's, Milton Friedman built on top of the existing Chicago School of Economics theory to further develop monetarist views in opposition to Keynesian economics. Friedman advocated for privatization and went so far as to blame the great depression on botched monetary policy. Stagflation, slow economic growth parallel to high inflation, a previously unseen phenomenon crept into global markets and monetarism began to gain popularity through its focus on price stability, as Keynesian economics lost momentum. It was argued that money supply should be provided to the economy in a slow predictable manner to allow for steady growth. During this time supply-side economics, also known as trickle-down economics developed. Trickle-down economics is pro deregulation and the cutting of taxes for corporates.

Modern main stream economics frequently combines elements of classical economics, monetarism and Keynesian economics into what is called new neoclassical synthesis.

The assumptions that are made in classical trade models are restrictive and emerging trade trends do not always fit the traditional international trade theory. The alternative approach to international trade theory is modern firm theory. Modern firm-based theory started forming after World War II, in line with the growth of multi-national companies. Country based theory, as found in classical trade models, was unable to cater for intra-industry trade nor able to explain the growth of multi-national companies. Sandrey and Fundira (2012) define intra-industry trade as the simultaneous import and export of goods within the same industry. An example of intra-industry trade would be if a firm in Japan, Toyota, sells cars to consumers in Germany, while BMW, a firm

in Germany sells cars to consumers in Japan. A South African agricultural example of this is wine; South Africa exports wine to France, but also imports wine from France. Why would this kind of trade take place? Firm based theories attempt to answer this question and hypothesize about consumer preferences for particular brands or quality levels of a good, as well as what exactly gives a firm a competitive advantage or makes a certain industry more competitive than others.

In 1961, Steffan Linder proposed a demand-based economic hypothesis, the country similarity theory, that postulated that countries with similar GDP per capita will have similar demand for products, which would lead to trade between firms in these countries. Linder conjectured that countries with similar demands would develop similar industries. These nations would then trade with each other in similar, but quality differentiated goods (Lancaster, 1980). Linder's hypothesis is contrarian to that of the Heckscher-Ohlin theory, which is a typical supply-based theory of trade. Heckscher-Ohlin theory suggests that countries export goods that use their abundant factors of production the most intensely. As the production of capital-intensive goods is associated with higher income levels compared to labour-intensive goods, this would mean that countries with dissimilar incomes would produce dissimilar products and would therefore trade with each other. Alcalá (2016) discusses the concept of specialization along the quality dimension of a good rather than simply the specialisation of production of one good over another. The outcome of the paper was that, through a many country, many industries Ricardian model, the quality of a country's exports of a given good increases with the country's revealed comparative in the production of the good, conditional to wages.

In the 1960's, Raymond Vernon who was unconvinced by traditional trade theory and its restrictions, developed the product life cycle theory. He placed emphasis on scale and innovation and assumed that knowledge is not a free good, contrary to traditional trade theory (Mullor-Sebastian, 1983). His research lead him to suggest that developed countries spend more capital on product development and that they generally develop labour saving goods. He believed that a new product would be solely produced in the country that it was first created. Only once a product had matured in the market would production move to lesser developed countries for cost saving reasons. Goods in their growth stage of production are typically exported to lesser developed countries where as goods in their mature stage are exported to developed countries according to Vernon.

Global strategic rivalry theory was developed by Paul Krugman and Kelvin Lancaster in 1980. Lancaster (1980) stated that comparative advantage was not a sufficient explanation for the high volumes of intra-industry trade that have been reported between countries that are similar in all aspects. Both Lancaster and Krugman explored the concept of perfectly monopolistic competition and how it fits into international trade. They believed that a multi-national company needed to follow a competitive strategy to gain a competitive advantage in order to outcompete global competition. This can be achieved by firms building up the barriers to entry into the markets that they operate in. Firms can do this by increasing their research and development, by obtaining ownership of intellectual property rights, by monopolising key resources, by leveraging economies of scale, and by developing novel methods for production or ways of doing business that their competitors cannot replicate easily. A related theory is that of Porter's national competitive advantage.

Porter's national competitive advantage theory is a well-known model that was developed by Michael Porter in 1990. He focused on explaining why some countries are simply more

competitive than other countries in a specific industry. The theory postulates that a country's competitiveness in an industry is reliant on the ability of that industry to innovate and continually evolve. Unlike traditional trade theory such as comparative advantage which focuses on the endowments of a country, Porter placed a heavy dependence on the behaviour of firms in determining national competitiveness of the industry and therefore its level of exports (Van den Bosch & van Prooijen, 1982). Porter branded four factors as the main determinants of competitiveness in an industry; the resources and capabilities of the domestic market including factors of production (factor conditions), domestic demand and consumer preferences (demand conditions), domestic supply and complementary industries (related and supporting industries), and lastly the dynamic between domestic firms and their individual characteristics (firm strategy structure and rivalry) (Van den Bosch & van Prooijen, 1982; Van Rooyen et al., 2011). Two exogenous influences are also discussed by Porter (1990); the role of chance and the policy and support structures provided by government (Van den Bosch & van Prooijen, 1982; Van Rooyen et al., 2011). Both of these factors are out of the control of firms but can still have a significant influence on the international competitiveness of an industry.

There are many different theories on international trade, but often it seems that in practice a combination of theories applies.

2.2.2. Trade Balance and Terms of Trade

A country's balance of trade has an effect on its total GDP (Equation 2-1). A trade surplus occurs when the total value of goods and services that are produced domestically and sold to firms in other countries exceeds the total value of foreign goods and services bought by domestic consumers, which means that there is a net inflow of money into the country as a result of trade (Encyclopedia Britannica, 2020).

Equation 2-1

$$GDP = private\ consumption\ spending + investments + government\ spending + (exports - imports)$$

The 'terms of trade' is the ratio between a country's export prices and its import prices (Equation 2-2). When the terms of trade is less than 100%, then more capital is leaving the country than entering it. The terms of trade is partially dependent on the exchange rate and the rate of inflation, both of which can fluctuate due to external and internal market factors The terms of trade ratio is commonly used as a measure of economic health for a country, but can be deceptive because price changes on a major imported commodity such as oil can have a large impact on a country. This provides some context as to why it is risky for a country to be largely dependent on a single commodity for both exports and imports.

Equation 2-2

$$Terms\ of\ trade = \frac{price\ of\ exports}{price\ of\ imports} \times 100$$

2.2.3. Trade Creation and Trade Diversion

Jacob Viner established the theory of customs unions in 1950. The theory predicts that following the implementation of a free trade agreement, a once-off re-allocation of resources will lead to trade creation or trade diversion. Trade creation is the replacement of high cost domestic

production with low cost imports, whereas trade diversion is the replacement of low cost international imports with high cost imports from other member countries of a particular free trade agreement (Deme & Ndrianasy, 2017). The theory of customs unions can be illustrated through a simple example. There are three small countries A, B and C. The cost of production in A>B>C. Assuming competitive markets under a global non-prohibitive tariff imposed by country A, firms in A would import goods from the most efficient producer, which is country C. However, if country A had a free trade agreement with country B, then firms in country A would import goods from country B instead of country C, thus resulting in a trade diversion. Viner concluded that the net effect of trade creation and diversion on consumer welfare is determined by the magnitude of the relative forces of trade creation and diversion of the free trade agreement in question.

Trade deflection, which is also known as transhipment can be a side-effect of free trade agreements and can to some degree undermine the success of such an agreement. Transhipment occurs when an exporting country side steps an importing country's trade policies by way of shipping the good through a third-party country that is part of a preferential or free trade agreement with the eventual importing country (Thompson-Lipponen & Greenville, 2019). 'Rules of origin' are one method that can be used in conjunction with free trade and preferential trade agreements to prevent trade deflection from taking place. 'Rules of origin' ensure that goods are taxed based on their original place of production. The World Trade Organisation has guidelines for the implementation of 'rules of origin' within trade agreements.

According to Balassa (1976), economic integration is both a process and a state of affairs. In the process sense, it encompasses measures that are intended to eliminate discrimination between economic units of different countries but when looking at it as a state it refers to the level of absence of discrimination between countries (Sapir, 2011). Balassa distinguished five different degrees or stages of economic integration (Table 2-1). It is important to note that the stages of integration are not necessarily sequential and that following Balassa's work there are now additional recognised stages. Monetary unions are common markets with a shared currency. Political unions are essentially the equivalent of Balassa's 'complete economic integration' stage as they represent the union of smaller states into one larger state.

Preferential trade agreements have grown in popularity over the last 30 years. This is evidenced by the increasing number of preferential trade agreements in effect. The majority of these agreements result in the formation of free trade areas rather than customs unions (Facchini et al., 2013). Free trade areas offer much lower economic integration than other forms of preferential trade agreements (Table 2-1). The higher the level of economic integration achieved by a preferential trade agreement, the more compromise is required from participating countries when it comes to decision making on economic policy and tariffs, which may reduce their competitiveness.

A customs union is generally seen to be more beneficial from a welfare point of view than a free trade area but there are certain complexities and difficulties involved with being part of a customs union. The external policies of free trade areas are not decided jointly, but in a customs union common external tariffs have to be voted on and decided on in co-operative manner that does not always suit all of the member countries. Thus, in a customs union, tariff co-ordination can prove to be a complex process. Strategic decisions are taken by the member countries when voting and often the average voter will delegate their voting power to a more highly protectionist representative (Facchini et al., 2013). Free trade areas and most favoured nation regimes do not

require tariff co-ordination. When member countries have fairly equal income and their production structures are alike, their customs union is more likely to have a balanced political equilibrium (Facchini et al., 2013).

Table 2-1 Stages of Economic Integration

	No Internal Trade Barriers	Common External Tariff	Factor and Asset Mobility	Common Economic Policy	Common Currency
Free Trade Area	Yes	No	No	No	No
Customs Union	Yes	Yes	No	No	No
Common Market	Yes	Yes	Yes	No	No
Economic Union	Yes	Yes	Yes	Yes	No
Complete Economic Integration	Yes	Yes	Yes	Yes	Yes

Source: Derived from Balassa (1976) and Sapir (2011)

The European Union is an example of a monetary union. There is interest amongst African politicians to consider a common currency across African countries, but concerns around the lack of institutional stability and competency to manage a common currency in the case of economic shocks has halted any real progression in discussions. International trade could see a boost from the formation of a common currency in Africa, but as mentioned before, this does not seem to be a feasible option. Qureshi and Tsangarides (2012) suggest an alternative option, where African countries peg their currencies to a common anchor currency. This suggestion would allow countries to retain flexibility with regard to their monetary policies whilst improving exchange rate stability and lowering transaction costs so as to encourage trade.

The current state of economic integration in Africa will be outlined and further discussed in the next sub-section of this chapter.

2.3. African Trade

The problem statement given in Chapter 1 is that Africa is currently not reaching its full potential for intra-regional trade, particularly with regard to agricultural goods. This sub-section of the Chapter gives context on the existing African trade trends for agricultural goods as well as the free trade agreements that are in place.

2.3.1. The Importance of Regional Integration

Regional integration features prominently as a development strategy around the world, as it has both economic and political benefits. Regional integration is the co-operation of countries that goes beyond increased trade and preferential trade agreements. It extends to creating a peaceful and secure region with better access to markets through reduced customs burdens and improved infrastructure, and in some cases allowing the flow of people between countries. Regional integration encompasses joint investment into infrastructure projects, the implementation of policies to catalyse industrial development and general research and development to grow regional markets. This is not to say that intra-regional trade is not a key focus of regional integration, but rather that it should be viewed an output within the context of the environment that it is in, thus allowing for more practical and sustainable policy decisions to be made. One can look to the Association of Southeast Asian Nations to see an example of how a region, with its own set of unique circumstances, has integrated itself to great benefit.

The Association of Southeast Asian Nations (ASEAN) region is a good example of where regional integration has succeeded; from 1993-2013 intra-ASEAN trade increased at an average rate of 10.5% each year, while overall ASEAN trade grew at an average rate of 9.25% per year (Pangestu & Ing, 2016). One of the core aims when ASEAN was originally established was to “collaborate more effectively for the greater utilization of their agriculture and industries, the expansion of their trade, including the study of the problems of international commodity trade, the improvement of their transportation and communication facilities and the raising of the living standards of their peoples” (Cuyvers et al., 2019). Regional integration nurtures intra-regional trade through joint investments in infrastructure projects. It also creates a market for the development of new industries by leveraging joint bargaining power (Ebaidalla & Yahia, 2014).

Bottasso et al. (2018) highlight the fact that improving infrastructure networks can stimulate regional competitiveness, drive economic development and impact trade openness within a region. Co-cooperativeness amongst governments within a region can lead to many benefits including indirect ones such as increased trade due to increased political stability and peace between neighbouring countries. Increased connectivity through trade between African countries can create growth spill overs and stimulate regional economic growth in the form of neighbourhood effects (Longo & Sekkat, 2004). Neighbourhood effects are the benefits that spill over from one country into one or more countries that it shares a border with. These benefits can be in the form of investment, human capital, institutions, political stability and trade (Behar & Manners, 2010). Improvements in technology across a region cuts down on the time and cost of doing business within the region. Whereas, the sharing of human capital for the benefit of the region either through joint research projects or through the migration of people increases knowledge transfers and increased capacity of skilled labour.

Intra-regional trade enables the pooling of resources that grows the capacity of the involved countries to compete with developed markets. Economies of scale is a major reason why intra-African trade agreements are important. Regional integration enables countries with smaller economies to increase their competitiveness through collective bargaining power. A good example of this is the Southern African Customs Union (SACU), whereby Eswatini and Lesotho are able to leverage off the larger economy of South Africa and overcome the constraint of their smaller economies. In doing so, these countries can increase their export competitiveness and benefit from economies of scale and increased bargaining power. Another key reason for

increasing intra-African trade is that regional trade is generally better protected from external shocks and global volatility. A strong regional trade base provides cushioning from exogenous shocks such as a global market crash or pandemic. In the time period following the global economic crash in 2008, Asian countries were able to support their trade performance through strong intra-regional trade to combat the general downturn of global demand for their goods (UNCTAD, 2013).

Job creation is another advantage to increasing regional integration through trade. The more a country is exporting the larger it can grow its sectors that are contributing. The spill over from this of course is that there will be an increased demand for labour in sectors such as trade and logistics which play a supporting role in trade. Anyanwu (2014) shows that intra-African trade is able to boost employment, including that of the youth. In 2015, youth unemployment in Africa was already particularly high at 31% but is expected to increase as an indirect impact of the COVID-19 pandemic in 2020 making job growth an employment a likely focus area for Africa going forward.

There is a lot of noise in literature about how Africa should be trying to increase intra-regional trade, but is intra-African trade really more beneficial than extra-African trade? The answer is yes for all of the above listed reasons; job creation; risk management and cushioning against exogenous shocks to the global market; increased pooling of resources and leveraging economies of scale; more infrastructure development and investment; and economic growth. However, it is worth highlighting, keeping trade diversion and creation theory in mind, that intra-African trade is not worth forcing at any cost, but rather needs to be stimulated in such a way that it is welfare improving. Replacing cheap extra-African imports with more expensive intra-Africa imports is not the objective. The idea is to achieve self-sufficiency and increase competitiveness, but not to eliminate trade with all other regions, where welfare gains can still be benefited from.

2.3.2. Regional Economic Communities and Preferential Trade Agreements

The nature of Africa's trading relationships has transformed over the last decade, as the region has gradually reduced its proportion of trade with its traditional partners, the European Union and the United States of America (tralac, 2019). New trading partners have arisen, and more trade is taking place with other emerging markets, especially the BRICS (Brazil, Russia, India, China and South Africa) bloc.

Regional trade agreements are growing in popularity among low income developing countries but the literature on the welfare effects of such agreements is not comprehensive. These agreements tend to be dominated by countries that have small share or total exports making up intra-regional flows (Deme & Ndrianasy, 2017). Regional economic communities are defined by the African Union as regional groupings of African countries that have been independently formed, with the general purpose of facilitating economic regional integration (African Union, 2014). The African Union recognizes eight regional economic communities, namely the Common Market for Eastern and Southern Africa (COMESA), the East African Community (EAC), the Southern African Development Community (SADC), the Economic Community of Central African States (ECCAS), the Economic Community of West African States (ECOWAS), the Intergovernmental Authority on Development (IGAD), the Arab Maghreb Union (AMU) and the Community of Sahel–Saharan States (CEN-SAD).

There are other regional economic cooperative bodies that the African Union doesn't formally recognise; the three major ones are the Southern African Customs Union (SACU), the West African Economic and Monetary Union (WAEMU/UEMOA) and the Economic and Monetary Community of Central Africa (CEMAC). SACU was started in 1910. In October 2002, South Africa, Botswana, Namibia, Lesotho and Swaziland (now Eswatini) signed a new SACU Agreement. The five member states have historically close economic relationships and four of the member countries form part of a monetary union. South Africa has a major economic dominance over the other members of SACU (Kirk & Stern, 2005). The West African Economic and Monetary Union (WAEMU) was established when a treaty was signed in 1994 by the government heads of state of the participating countries. The 7 member states use the West African CFA franc as currency. The West African CFA franc is backed by the French treasury and is pegged to the Euro. The Central African Economic and Monetary Community (CEMAC) was founded in 1999. The 8 member states all use the Central African CFA franc as a common currency. The economic union element of CEMAC is not yet fully operational and is still in the process of being set-up

Member States of the regional economic communities are either for historical, political or economic reasons, generally members of more than one regional economic community (UN, 2016). The inefficiency of the overlapping of regional economic community memberships in combination with an array of inter-governmental organisations in Africa, creates a challenge for true African integration and the implementation of effective regional agreements (tralac, 2019). On average each African country has two REC memberships (Table 2-2). Some of the regional economic communities have custom's unions but others are simply free trade areas.

Table 2-2 Regional Economic Community Membership

Country	AMU	CEN-SAD	COMESA	EAC	ECCAS	ECOWAS	IGAD	SADC
Algeria	X							
Angola					X			X
Benin		X				X		
Botswana								X
Burkina Faso		X				X		
Burundi			X	X	X			
Cabo Verde						X		
Cameroon					X			
Central African Republic		X			X			
Chad		X			X			
Comoros		X	X					X
Congo					X			
Democratic Republic of Congo			X		X			X
Djibouti		X	X				X	
Egypt		X	X					
Equatorial Guinea					X			
Eritrea		X	X				X	
Eswatini			X					X
Ethiopia			X				X	

Country	AMU	CEN-SAD	COMESA	EAC	ECCAS	ECOWAS	IGAD	SADC
Gabon					X			
Gambia		X				X		
Ghana		X				X		
Guinea-Bissau		X				X		
Guinea						X		
Ivory Coast		X				X		
Kenya			X	X			X	
Lesotho								X
Liberia						X		
Libya	X	X	X					
Madagascar			X					X
Malawi			X					X
Mali		X				X		
Mauritania	X	X						
Mauritius			X					X
Morocco	X	X						
Mozambique								X
Namibia								X
Niger		X				X		
Nigeria		X				X		
Rwanda			X	X	X			
Sao Tome and Principe					X			
Senegal		X				X		
Seychelles			X					X
Sierra Leone		X				X		
Somalia		X	X				X	
South Africa								X
South Sudan				X			X	
Sudan		X	X				X	
Togo		X				X		
Tunisia	X	X	X					
Uganda			X	X			X	
United Republic of Tanzania				X				X
Zambia			X					X
Zimbabwe			X					X

Source: Adapted from UNCTAD (2019) and the REC's websites

Most favoured nation tariffs are the highest tariffs that World Trade Organisation members can charge one another (The World Bank, 2010). Most favoured nation tariff regimes lack consistency across the members of the African Union, even within regional economic communities. Free trade areas within Africa contain members that operate on different ends of the spectrum of economic openness. This lack of consistency results in trade diversion problems, with increased intervention

costs. The regional economic communities have different roles and structures, as a result of their independent formation and the unique requirements of the different regions that they serve.

The AMU was founded in 1988 and is one of the smaller regional economic communities, with only five member states. Conversely, COMESA, founded in 1993, is one of the largest regional economic communities and has a developmental approach to regional integration. The main objective of COMESA is to act as a large economic and trading unit, enabling smaller states to overcome the barriers to trade that they face. The GDP size of the region allows it to make better trade deals than what the smaller individual states would be able to negotiate on their own. It has a free trade area and a non-operational customs union. It has 19 member states and its free trade area is fully in force. CEN-SAD was formed in 1998, with the purpose of encouraging economic, social, cultural and political integration amongst its 29 member states. Its free trade area has stalled. The EAC was established in 1999, as a regional intergovernmental organization. The core purpose of the EAC was to increase regional trade integration through the member's trade policies. It has an operational customs union and a common market. ECCAS was formed in 1983 to further an agenda of social development and to improve the livelihood of people living in the region. There are 10 member states but the free trade area is not yet enforced. Inançli and Addi (2019) have determined that ECCAS, unlike some of the other RECs, does not have trade creation or diversionary effects. ECOWAS has been in existence since 1975. ECOWAS is the regional economic community that has the lowest proportion of most favoured nation tariffs at zero and the highest proportion of nuisance tariffs (Stuart, 2017). It has 15 member states participating in its free trade area. Originally, in 1986, IGAD was founded as the "Intergovernmental Authority on Drought and Development" to provide support during a period of multiple severe droughts. The revitalised IGAD was established in 1996 to develop joint strategies and achieve policy harmonisation across members. It has 8 members and the free trade area is in force. The SADC was established in 1992 with broad key objectives covering both economic and social welfare. The aim of the SADC is to increase development and economic growth through a free trade area, but also to assuage poverty and improve the standard of living of people in Southern Africa (tralac, 2019). SADC's membership is comprised of SACU countries and a diverse spread of other countries that fall on both ends of the spectrum in terms of openness of tariff regimes, totalling 15 members (Stuart, 2017).

Table 2-3 Regional Economic Community Preferential Trade Agreements

	Free Trade Area	Customs Union	Single Market	Monetary Union	Economic Union
AMU	Planned	Planned			
COMESA	Yes	In progress	Planned	Planned	
CEN-SAD	Planned	Planned			
EAC	Yes	Yes	Yes	Planned	Planned
ECCAS	Planned	Planned			
ECOWAS	Yes	Yes	Planned	Planned	
IGAD	No				
SADC	Yes	Planned	Planned	Planned	

Source: Adapted from UNCTAD (2019)

Thus far, it is not clear whether regional integration has increased trade amongst African countries or not (Ngepah & Udeagha, 2018). In some cases, it is believed that they have in fact complicated administrative procedures and increased trade costs rather than reduced them (Jordaan, 2014). When a country belongs to more than one regional economic community, the differing rules of the regional economic communities' trade agreements can confuse customs procedures, especially where weak poorly managed institutions are involved. The complexity of managing these administrative requirements can prove to be beyond the capabilities of the customs bodies and lead to delays in the goods being cleared for export or import. The state of the infrastructure and institutions of a country also play a vital role in determining the success of trade integration with another country (Jordaan, 2014). The United Nations (2013) identified the fact that with the exception of the ECCAS, regional economic communities' intra-African trade is limited mostly to their own regional trade bloc and doesn't extend to African countries falling outside of their trade bloc. During the course of 2018, 20% of intra-Africa exports were exports between members of SACU, 4% were among EAC members, 13% were from ECOWAS members to ECOWAS members and less than 1% of exports were intra-CEMAC (tralac, 2019). The statistics generally show that most African countries' intra-African trade is within their regional economic communities.

The web of regional economic communities across Africa are inefficient, as some countries are members of multiple trade blocs but when one analyses the effect on bilateral trade, it is possible to see that up to two thirds of trading partner combinations do not benefit from a free trade area agreement. Ngepah and Udeagha (2018) classify the African regional trade agreements into tariff classes for the period of 1995-2014. The COMESA, EAC, ECOWAS, SADC, AMU and CEN-SAD were classed as having high-low tariff trends, which means that countries in these arrangements have largely kept to their commitments and reduced tariffs in the latter part of the time period measured. The CEMAC, ECCAS and IGAD are categorised as having high-high tariff trends, which means that member states have made little attempt to lower their tariffs in accordance to their agreements. The third class of tariff trends is low-low, which is when countries that are part of the agreement have continued to keep tariffs low throughout the time period. The WAEMU and SACU both fitted this description of low-low tariff trends.

The concept of the COMESA-EAC-SADC Tripartite Free Trade Area (TFTA) agreement was agreed on in 2008, but only officially launched in 2015 and has still not been implemented. The main goal of the TFTA was to merge the three regional economic communities in order to reduce the overlapping memberships and to bring about a more organised framework for promoting intra-African trade (Erasmus, 2020). Although 22 countries across the three regional economic communities have signed the declaration, as at April 2020, only eight countries out of the proposed 27 have ratified the agreement. A minimum of 14 countries need to ratify the agreement before it can be entered into force (tralac, 2019). With the arrival of the African Continental Free Trade Area (AfCFTA) agreement, one might question the relevance of the TFTA. The TFTA still has promise and once ratified by the prerequisite number of countries, could play an important role in advancing the agenda of the AfCFTA, but it remains yet to be seen how the AfCFTA will impact on the existing regional communities and trade agreements. It has been agreed that the existing regional economic communities will remain operational and Erasmus (2020) holds the view that the AfCFTA does not preclude new agreements for co-operation from being formed, given that they meet the mutually agreed standards of the AfCFTA. There is, however also an expectation that over time the existing regional economic communities will gradually be rationalised and aligned.

The most important free trade area for intra-African trade going forward is undoubtedly going to be the AfCFTA. In January 2012, at the 18th AU Assembly, it was decided that the AfCFTA would be established in order to pursue a larger degree of developmental regionalism on the African continent. The AfCFTA came into effect for 24 of the 55 countries on the 30th of May 2019, however tariff schedules, rules of origin and regulations specific to the trade of services have not yet formally been agreed on (Erasmus, 2020). Preferential trade under the AfCFTA was scheduled to begin on 1 July 2020, but this deadline has been moved out due to COVID-19 and trade may only begin in 2021. As at June 2020, 54 countries have signed the AfCFTA and 28 countries have ratified the agreement (Viljoen, 2020). The AfCFTA was designed to stimulate production and industrialization, which in turn will create employment and alleviate poverty, whilst deepening the level of integration between countries. As Chaytor (2019) puts it, the AfCFTA is a "mega trade arrangement" with massive scope, as it brings together all eight regional economic communities and the 55 member states of the AU to create a single continental market for goods and services. To put this in perspective, the AfCFTA will be the largest free trade area in the world since the World Trade Organization (WTO) was formed. The Economic Commission for Africa estimates that the AfCFTA could increase intra-African trade by up to 52% simply through the elimination of import tariffs (tralac, 2019). If non-tariff barriers are also reduced, then the positive impact on intra-regional trade could double. The Economic Commission for Africa's model projections estimate that the AfCFTA could increase intra-African trade of agricultural goods by 20 to 30 percent. The model identifies that the largest increases will be for sugar, vegetables, fruit, nuts, beverages and dairy products (Songwe, 2019). The idea is that the AfCFTA will eventually result in the formation of an extensive customs union. In theory the AfCFTA should solve for the inefficiencies of the current regional economic communities by increasing trade harmonization through organized trade liberalization efforts and by improving trade facilitation. Poor transportation networks, under developed infrastructure, and low resource complementarity, in combination with high trading costs from non-tariff barriers limit the benefits of the current regional trade agreements in Africa (Yang & Gupta, 2007). To successfully boost intra-African trade, the AfCFTA will need to be supported by investment in infrastructure and trade facilitation across Africa. The AfCFTA will necessitate an improvement in customs administration across the continent and establish structures to regulate services trade between African countries. Realistically the benefits of the agreement will not be seen in the immediate short term as co-ordinated action amongst governments and domestic reforms will be needed before implementation is successful.

2.3.3. Trade Trends

Trade trends are important in giving an overview of the current state of trade. This section looks at trends involving intra-regional trade, dominant importers and exporters on the African content, the composition of trade and the propensity of African countries to trade with their neighbours.

2.3.3.1. Intra-regional Trade

Intra-continental trade data shows that Africa and Oceania have the lowest proportions of intra-continental trade (Figure 2-1 and Figure 2-2). There is a substantial gap between Africa and Oceania and the rest of the continents. The low level of intra-continental trade for Oceania is not unexpected, as Oceania only covers a land area of 8.5 million km^2 comprising of 14 countries. Whereas, Africa in relative terms should be trading more with itself, as it is comparable in size to North and South America combined and much larger than Europe. This clearly indicates that intra-

regional trade must be determined by more than simply the number of countries in a region and the land area of a region.

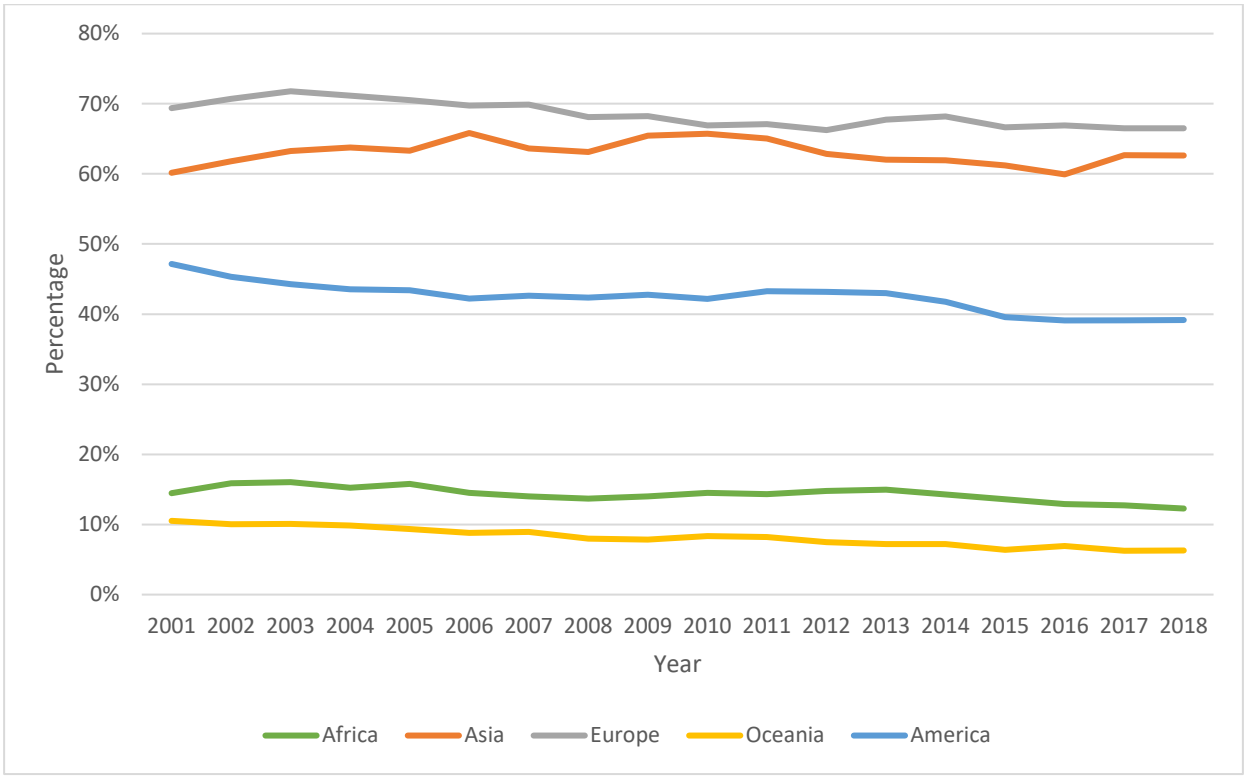


Figure 2-1 Intra-Continental Imports of All Products as a Percentage of Total Imports 2001-2018 (All Goods)

Source: International Trade Centre (2019)

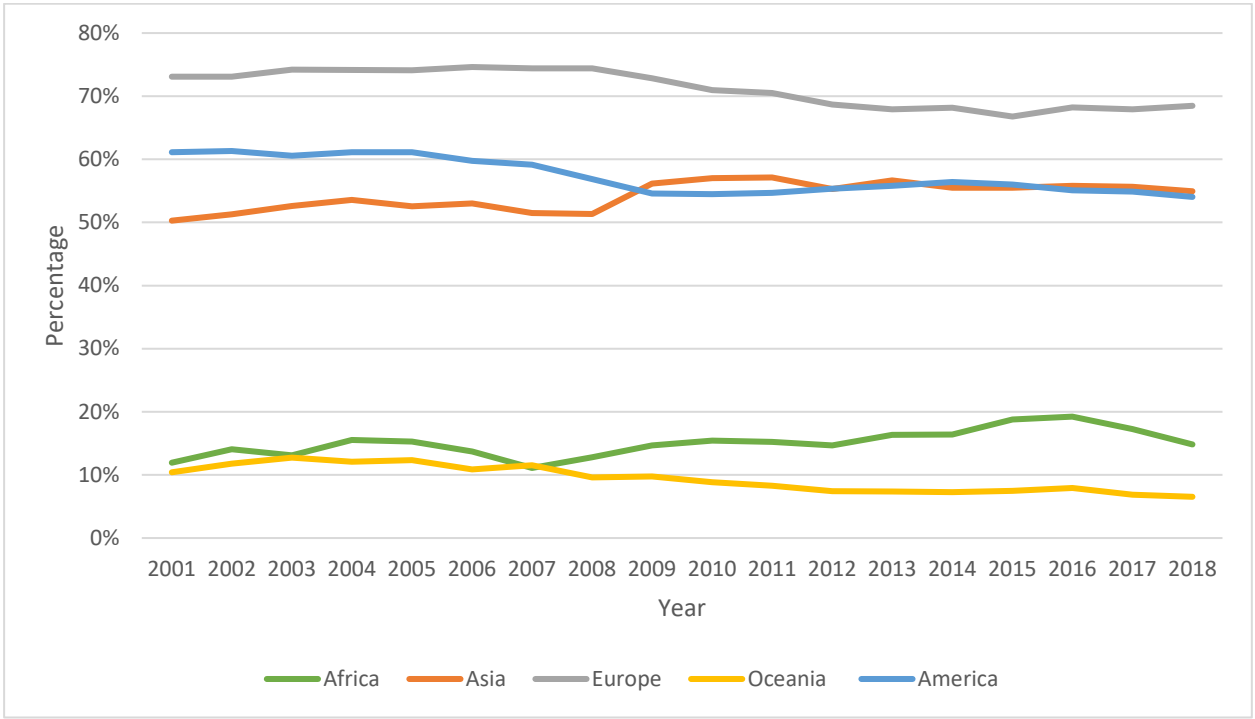


Figure 2-2 Intra-Continental Exports of All Products as a Percentage of Total Exports 2001-2018 (All Goods)

Source: International Trade Centre (2019)

Regional trade composition varies across the world. Table 2-4 shows the percentage of agricultural exports that were intra-regional in 2018, for the listed geographical regions, whereas Table 2-5 shows the percentage of agricultural imports for a region that were intra-regional. These two sets of percentages offer insight into the state of agricultural production and trade for these regions. Europe has the highest amount of intra-regional trade both in terms of agricultural imports and exports. Asia and Africa have relatively higher percentages of intra-regional trade for exports than what they do for imports, whereas Oceania, the Americas, and have a higher level of intraregional trade for their imports. One can also see that Oceania, the Americas and Europe are net exporters of agricultural goods by value, but that Asia and Africa are net importers of agricultural goods.

Table 2-4 Regional Agricultural Goods Export Value and Percentage of which was Intra-Regional Exports

Region	Exports of Agricultural Goods in 2018 (USD thousand)	Intra-regional Exports of Agricultural Goods (%)
Oceania	49 935 848	8
Africa	43 420 352	21
The Americas	325 734 254	42
Asia	211 553 701	68
Europe	509 711 124	75

Source: International Trade Centre (2020)

Table 2-5 Regional Import Value Agricultural Goods and Percentage of which was Intra-Regional Imports

Region	Imports of Agricultural Goods in 2018 (USD thousand)	Intra-regional Imports of Agricultural Goods (%)
Africa	61 071 921	14
Oceania	16 402 371	27
Asia	378 391 048	32
The Americas	218 059 505	67
Europe	487 232 251	76

Source: International Trade Centre (2020)

There are a few reasons for the discrepancy that can be observed across regions. The size of the domestic markets in combination with the region's comparative advantage to produce agricultural goods are contributing factors, but further discussion around factors that influence trade will be covered in a later sub-section of this chapter.

2.3.3.2. Agricultural Goods compared to Other Goods

The share of intra-African trade in Africa's total trade has stayed low; the percentage of imports that are intra-African has varied between 16% and 12% from 2001-2018. Intra-African exports have moved between a range of 19% and 12% of total African exports for the period of 2001-2018. As at 2018, a greater percentage of agricultural goods were imported intra-regionally in Africa compared to all other goods (Figure 2-3).

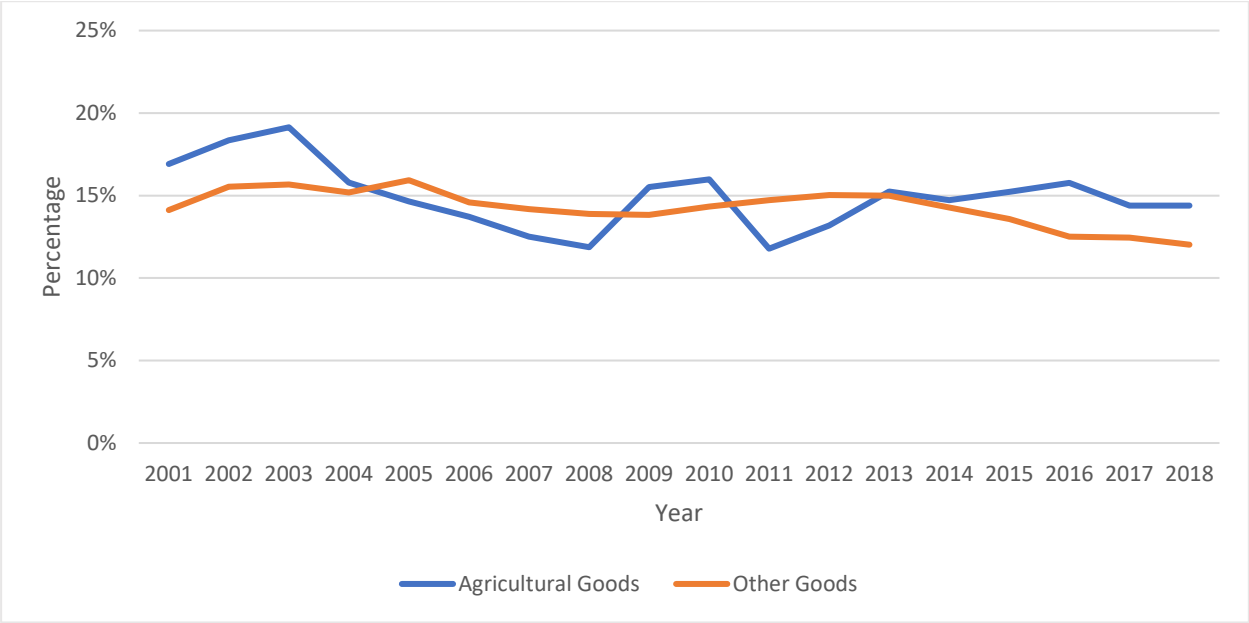


Figure 2-3 The Percentage of African Imports that came from other African Countries 2001-2018

Source: International Trade Centre (2020)

Intra-African trade has thus far not grown at the rate that would be expected, considering the opportunity for trade across various product types. It is, however important to remember that the informal sector in Africa is a large contributor to GDP and that informal trade is not accurately recorded on any of the available databases, which means that intra-African trade may be understated in official statistics (UN, 2013). Conversely intra-African trade data is sometimes guilty of having double counts that contribute to overcounting imports and exports by about 7-9%, which occurs due to overlapping regional economic community memberships (UNCTAD, 2019). As at 2018, intra-African agricultural imports made up 12% of total intra-African imports. On average for the time period of 2001-2018, intra-African agricultural imports have contributed to 11% of total intra-African imports on a value basis (Figure 2-4).

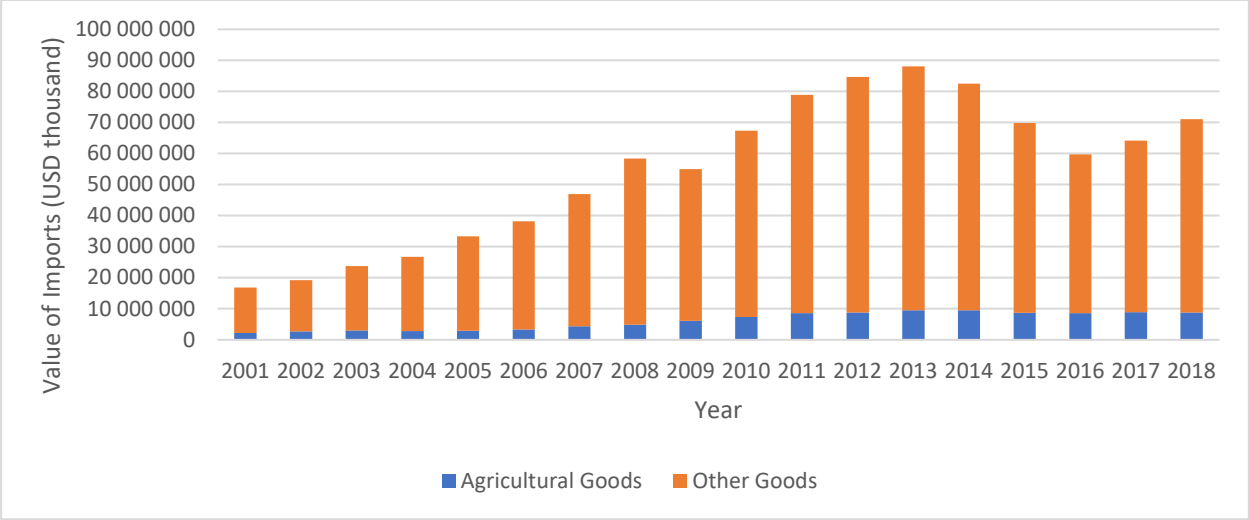


Figure 2-4 The Value of Intra-African Imports 2001-2018

Source: International Trade Centre (2020)

2.3.3.3. Major Importers and Exporters

In 2018, the African country that was most involved in intra-African trade was unsurprisingly South Africa, which has been able to continue to leverage off of the Southern African Customs Union. South Africa was the largest intra-African importer and exporter of total goods and agricultural goods in 2018 (Table 2-6). Namibia, the Democratic Republic of Congo and Botswana feature largely in intra-African imports of both agricultural and non-agricultural goods (Table 2-6). Egypt is a top 5 intra-African exporter of both agricultural and non-agricultural goods, whilst Kenya features as being highly involved in both the exporting and importing of agricultural goods within Africa.

Table 2-6 African Countries Most Involved in Intra-African Trade by Value in 2018

Largest Intra-African Exporters in 2018 by Value				
Rank	**Exporters of Agricultural Goods**	**Exports USD thousands**	**Exporters of All Goods**	**Exports USD thousands**
1	South Africa	3 285 791	South Africa	25 217 638
2	Uganda	801 861	Nigeria	6 996 266
3	Egypt	783 399	Egypt	4 768 224
4	Kenya	538 968	Ivory Coast	2 843 383
5	Ivory Coast	379 411	Zimbabwe	2 607 781
Largest Intra-African Importers in 2018 by Value				
Rank	**Importers of Agricultural Goods**	**Imports USD thousands**	**Importers of All Goods**	**Imports USD thousands**
1	South Africa	703 230	South Africa	11 688 252
2	Kenya	642 339	Namibia	5 422 967
3	Botswana	591 033	Zambia	5 027 559
4	Namibia	587 104	Botswana	4 291 930
5	Democratic Republic of Congo	519 706	Democratic Republic of Congo	3 352 393

Source: International Trade Centre (2020)

When looking at trade beyond the borders of Africa, South Africa still remains the largest importer and exporter of most categories, with the exception of Egypt being the largest importer of agricultural goods on the African continent in 2018 (Table 2-7). Countries that do not feature majorly in intra-African trade, but do in overall trade are predominantly North and West African countries, namely Morocco, Algeria, and Nigeria.

In terms of where African agricultural exports go, the answer is principally Europe and Asia (Figure 2-5). Growth in agricultural exports to Asia has continued to climb over the last 18 years. The two largest Asian importers of African agricultural goods in 2018 were China and India. The agricultural products typically imported by Asian countries from Africa are edible fruits and nuts, cocoa and oil seeds. In 2018, the Netherlands and France were the largest European importers

of African agricultural goods. The agricultural goods by trade value that are most imported by European countries are cocoa, edible fruits, nuts and vegetables. The Americas and Oceania do import some agricultural goods from Africa but much less than other regions.

Table 2-7 African Countries Most Involved in Trade by Value in 2018

Largest African Exporters in 2018 by Value				
Rank	**Exporters of Agricultural Goods**	**Exports USD Thousands**	**Exporters of All Goods**	**Exports USD Thousands**
1	South Africa	8 925 465	South Africa	95 179 154
2	Ivory Coast	6 346 364	Nigeria	52 920 065
3	Egypt	4 409 087	Algeria	43 042 095
4	Ghana	4 035 976	Angola	42 021 981
5	Morocco	3 397 604	Libya	30 851 720
Largest African Importers in 2018 by Value				
Rank	**Importers of Agricultural Goods**	**Imports USD Thousands**	**Importers of All Goods**	**Imports USD Thousands**
1	Egypt	11 623 704	South Africa	94 023 947
2	Algeria	6 529 666	Egypt	82 444 514
3	South Africa	4 573 963	Morocco	51 253 928
4	Morocco	3 911 118	Algeria	49 501 039
5	Nigeria	3 066 243	Nigeria	36 477 277

Source: International Trade Centre (2020)

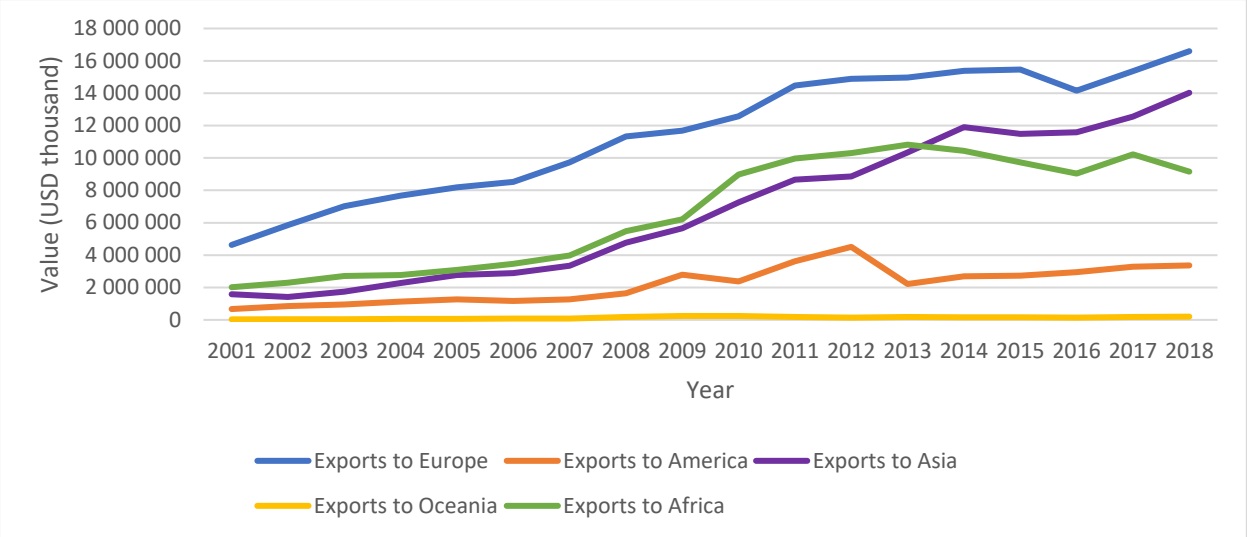


Figure 2-5 The High-Level Split between African Agricultural Goods Export Markets

Source: International Trade Centre (2020)

According to data from the International Trade Centre (2019), in 2001, South Africa was the largest African exporter of agricultural goods with 0.6% of world exports. To give this perspective the United States was the largest exporter of agricultural goods in the world and had a share of 12.9%. Fast forward 17 years to 2018 and South Africa now has a share of 0.8% of agricultural exports globally, showing that some growth has taken place, whereas the United States share has reduced to 10.3%. Figure 2-6 shows the biggest winners and losers of export market share from 2001 to 2018. Interestingly, no African country features in the Figure 2-6, although there has been a clear increase in exports from developing countries, particularly Brazil which has increased by 2.4 percentage points.

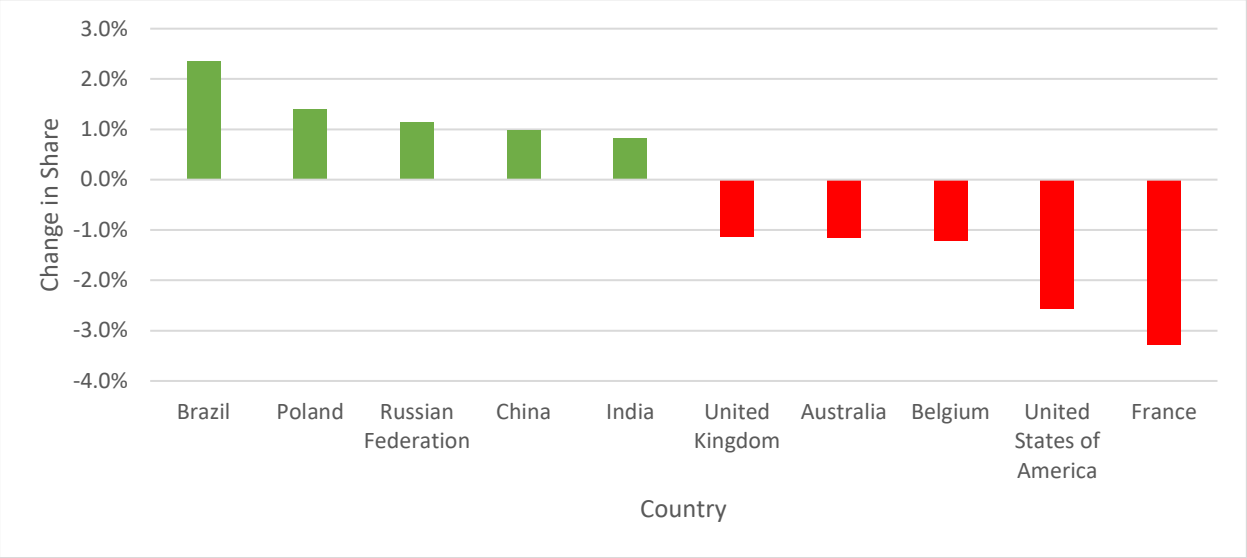


Figure 2-6 The Change in the Share of World Agricultural Exports: The Top 5 Gainers and Losers in the Share of Exports of Agricultural Goods by Value from 2001-2018

Source: International Trade Centre (2020)

2.3.3.4. Composition of Trade

Mineral fuels and mineral oils (HS ’27) contributed by value to 42.86% of total African exports in 2018 (ITC, 2020). Natural or cultured pearls, precious or semi-precious stones, and precious metals (HS ’71) contributed a further 10.37% to total African exports (ITC, 2020). The highest valued agricultural export in 2018 was edible fruit and nuts (HS ’08) which totalled USD 10 billion, contributing 2.12% to total exported value by African countries (International Trade Centre, 2020). These trade statistics illustrate that African countries are predominantly exporters of hard commodities.

Agricultural products such as wheat, maize, and coffee are usually classified as soft commodities, while hard commodities are extractive in nature, such as gold, iron and oil. A country is considered a commodity exporter, if more than a quarter of its goods exported consist of soft and hard commodities and net commodity exports are more than 5% of total goods traded. According to an IMF (2016) report, for the period 2010-2014, 22 Sub-Saharan African countries met the above criteria and were thus categorised as commodity exporters. Interestingly, 20 of those 22 countries were exporters of hard commodities. This is a significant increase from the 1990’s when only 14 Sub-Saharan African countries were considered hard commodity exporters. The only soft commodity exporter for the 2010-2014 period was Côte d’Ivoire, with its main export commodity

being cocoa. Africa has the highest dependence globally on the export of commodities, only after the oil rich Middle East. Commodity price cycles, which lead to price fluctuations, can have a substantial impact on these commodity exporting nations.

In 2018, Africa's largest agricultural exports by value were fruit and nuts; cocoa; and coffee and tea, whilst its largest imports by value were cereals; animal and vegetable fats; and sugars and sugar confectionary (ITC, 2020). Cereals are the largest import by value by more than double that of the next largest import – the difference equates to slightly less than $14 billion. Cereal imports are largely driven by shortfalls in supply on the African continent. Although Africa's largest agricultural exports by value are fruit and nuts which are unprocessed, this is beneficial as high-quality fruit can fetch a higher price in the international market than what processed fruit can. In other words, the export of processed goods is not always preferable to that of unprocessed goods.

In 2018, the agricultural products most traded by value between African countries at HS code level 4 was solid cane and sugar beet (Table 2-8). An interesting observation is that there is a correlation in the types of agricultural goods that are most traded between African countries by value and those that are most imported by African countries from the rest of the world by value. At a level 4 HS code, cane and beet sugar; palm oil; and maize feature in the top 5 agricultural goods imported by Africa from the rest of the world as well as agricultural goods imported by African countries from other African countries. This would indicate that either Africa cannot supply enough to satisfy its own demand, or that Africa cannot supply the full amount demanded at a low enough price to compete with imports from other parts of the world.

Although by value, maize is a major intra-African import, less than 10% of the maize imported by African countries in 2018 was from other African countries (Table 2-8). Wheat flour on the other hand, although smaller in value terms for intra-African imports, was actually 46.35% imported from African countries. When further analysing the trade of agricultural products, it becomes apparent that those that are largest in value for intra-African imports are not necessarily predominantly imported from African countries. Looking only at agricultural goods that have an intra-African import value of over USD 1 million in 2018, soup and broth preparations (HS '2104) had the highest African contribution to imports, at 76.61% (ITC, 2020). The next highest, according to this criterion was other oil seeds and oleaginous fruits (HS '1207) of which 67.51% is imported from other African countries (ITC, 2020).

Table 2-8 The Largest Intra-African Agricultural Imports of 2018 by Value and their Import Percentage Relative to Total Imports

HS Code	Product Label	Percentage that was Intra-African Imports (%)
'1701	Cane or beet sugar and chemically pure sucrose, in solid form	18.50
'1511	Palm oil and its fractions, whether or not refined (excluding chemically modified)	10.29
'0902	Tea, whether or not flavoured	43.48
'1005	Maize or corn	9.90

Source: International Trade Centre (2020)

2.3.3.5. Trading with Neighbours

In Africa there is a propensity for countries to trade first and foremost with their neighbours. Looking at the largest African exporters of agricultural goods and then checking which were the largest African importers of their goods, in 2018, provides evidence of the existence of a tendency for African countries to trade with their neighbours. The top African importer from Ivory Coast, is its neighbour Burkina Faso. The same applies to Morocco and Mauritania; Egypt and Libya; Ghana and Burkina Faso; South Africa and Botswana, Namibia and Mozambique - in all these cases the countries involved share a border and are neighbours. In the case of Ethiopia, Somalia is actually the biggest African and non-African importer of its agricultural goods. This cross-border phenomenon can be observed in the maize case study of Southern and East Africa by Davids et al. (2016) (Figure 2-7). From 2008 to 2016, South Africa, Zambia and Uganda all exported maize into other parts of Southern and East Africa, whereas Kenya, Zimbabwe, the Democratic Republic of Congo and Mozambique have consistently had a supply deficit (Davids et al., 2016). Southern African countries typically are in maize production deficit, whereas East African countries, located further North, tend towards producing a surplus in maize. Mozambique is a highly regional market, as high transport costs inhibit the trade of maize from Northern surplus countries to Southern deficit countries. The main maize flows show predominantly neighbours trade in this commodity in Southern and East Africa (Figure 2-7).

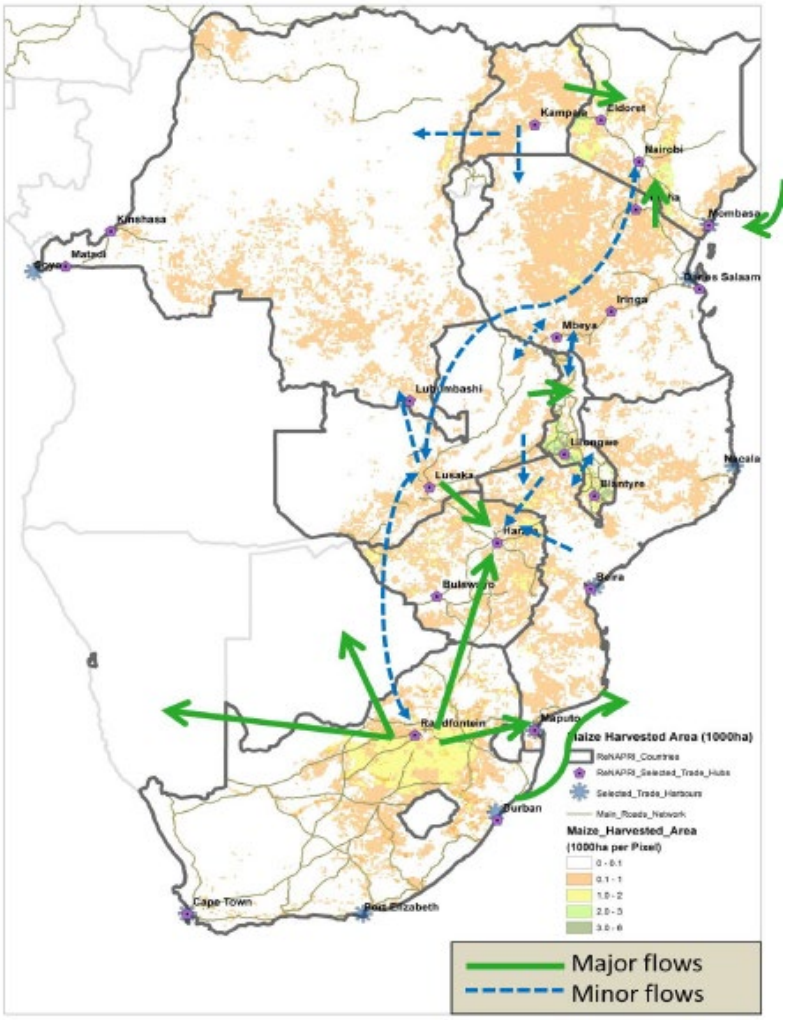


Figure 2-7 Typical Maize Trade Flows in Southern and East Africa

Source: Davids et al. (2016)

2.4. How is the Trade of Agricultural Goods Different to Other Goods?

Agricultural goods have some characteristics that result in their trade being impacted differently by certain factors compared to other types of goods. This sub-section explores what those characteristics are and why there are important for understanding the trade of agricultural goods.

2.4.1. Seasonality Considerations

Agricultural goods are often seasonal in nature which means that their production is not always year-round and can peak at different times of the year in different regions. This creates seasonal demand for certain agricultural goods, when their local producers are not producing. An opportunity for trade arises and countries that are in the production season can export to those that are not. For 3-5 months of the year, the United Kingdom imports zero apples from South Africa and New Zealand but these two countries can contribute to over 80% of total apple imports during the summer months (Muhammad, 2013). This is a typical example of counter seasonality and is common for Northern and Southern Hemisphere countries and their trade of agricultural goods. Counter seasonality is particularly relevant when considering how to increase intra-regional trade of agricultural goods, as countries in a similar geographical location will likely have similar production seasons which means that they will not be able to capitalise on off season trade; at best they will be able to trade to increase supply in the shoulder period.

2.4.2. Perishability

Not all agricultural goods are perishable but the importance of perishable agricultural goods in Africa is increasing due to a growing middle class, coupled with a positive expenditure elasticity for perishable foods, especially those with high value additions from processing (Tschirley et al., 2015).

Quality trade facilitation is likely more important for perishable agricultural goods exported from African countries than other goods due to their time sensitivity (Liapis, 2015). Agricultural goods unlike hard commodities can be perishable and are more sensitive to transport time and handling care. Not all agricultural commodities spoil at the same rate. Processed agricultural goods are less prone to spoilage, and highly perishable agricultural goods tend to be higher value goods that are transported raw. Fruit and vegetables are the agricultural goods that are most likely to spoil in transit. Some goods such as wine have very long shelf lives but are highly susceptible to breakage during transport and onloading and offloading processes. Freund and Rocha (2010) determined that an increase in inland transit times negatively impacts the export of time-sensitive goods far more than it affects the export of time insensitive goods. Delays in the export supply chain can result in reduced quality and spoilage of agricultural goods. As at 2015, 44-55% of the African middle class' food expenditure was on perishable products (Tschirley et al., 2015). Perishable agricultural goods are growingly traded over longer distances, as new sophisticated technologies enable the goods to last longer through improved post-harvest care and transport technologies such as remote container temperature controlling ability (Sippel, 2015). This point around perishability may, however, be more relevant for extra-African exports of agricultural goods as current statistics show that the agricultural goods most traded within Africa are not particularly perishable.

Time delays can have a varying effect on the quality and price of agricultural goods. In general, the more perishable a good the more sensitive the quality and price of that good will be to a time delay (Liu & Yue, 2013). Liu and Yue (2013) provide examples of agricultural goods with differing perishability and thus consequences of a time delay. Lettuce is a highly perishable good and is easily affected both in terms of price and quality. Apples are considered intermediately perishable and their quality will be impacted by time delays but not enough to majorly impact the price received from the importer.

The perishability of agricultural goods can also lead to high unit transport costs. The unit costs for overland transport of agricultural goods are high compared to high value products and hard commodities (Christ & Ferrantino, 2011). This is mostly due to perishable agricultural goods that require cold chain transport, which is more expensive due to the specialised equipment and electricity required to run refrigeration.

Agricultural goods' prices can fluctuate while in transit. Time lapsed can therefore be important in certain instances, as markets can change over the time that it takes to transport the goods. Food price volatility, especially for the core staple foods has been an ongoing challenge for Africa. The agricultural exports of developing countries are particularly sensitive to the quality of transport and trade related infrastructure (Moïsé et al., 2013).

2.4.3. Reliance on Climate

The resources required to produce agricultural goods are unevenly distributed across countries. The ability to supply agricultural goods does not correlate with the demand for agricultural goods, which means that there is significant scope for welfare gains from trade of these goods. Natural resources play a key role in creating agricultural trade patterns, but state policies are also influential in determining the ability of producers in a given country to compete internationally in the production of agricultural goods. Agricultural goods are predominantly food for human consumption, but depending on the situation can also include tobacco, alcoholic beverages, animal feeds and raw materials used for other purposes such as crops for biofuels. The development and use of technologies in production, combined with increased access to information and communication technologies, as well as improved transport and logistics services globally has led to increased trade since 2000. Demand for agricultural goods has grown particularly in countries that have experienced growth in productivity and income, and have not traditionally been strong importers or exporters of agricultural goods. Examples of such countries include Brazil, Russia, India, Indonesia and China, which have considerably outpaced the rest of the world in terms of growth in trade of agricultural goods (Beckman et al., 2017).

Climate and natural endowments to a large degree influence the comparative advantage of a country in producing agricultural goods. Countries that specialize in the production and export of a single agricultural commodity are vulnerable to changes in the external market. Any loss of competitiveness can be hugely detrimental to the overall health of their economy. Natural resources and human capital are generally more important than other factors for the success of the agricultural industry of a country and its ability to develop an export focus for agricultural goods. Changes in weather can shift demand and supply locally and internationally. Demand is typically inelastic and national supply is highly inelastic over the course of a single season (Haile et al., 2014), but drought in one part of a region may create an opportunity for another part of the region to export and supplement the local supply, even if only for a short time. The reason for this

is that although local supply is inelastic, supply on a global scale is fairly elastic as planting and harvesting occurs throughout the year.

2.5. Factors that Influence Trade

There are numerous factors that can drive or otherwise influence levels of trade between firms in different countries. This sub-section of the Chapter considers these factors and attempts to explain how they impact trade.

2.5.1. Costs

Reimer and Li (2010) calculated that world trade could increase up to 15 times, should all trade costs be removed. Exporters and importers both want to minimise the costs involved with trade to maximise their benefit from the transaction. Trade costs can be separated into three different parts of the export supply chain (Moïsé & Le Bris, 2013). Behind the border costs are those that include non-tariff regulatory processes such as access to trade finance, general business costs and market access restrictions. Crossing the border costs include documentation and customs compliance processes. Thirdly, there are certain costs are present at all stages of the international trade supply chain; logistics and transport costs are present from farm gate right up until delivery to the buyer. Due to the transversal nature of transport and logistics costs, they are the most critical of the costs to address.

The Global Enabling Trade Report 2016 lists documentary compliance, depots, border crossings, inland transport, customs clearance, container terminals and ocean transport as direct costs involved in the export leg of trade (Geiger et al., 2016). Indirect costs involved in the export leg of trade include losses, breakage and spoilage; transportation choice, detention of goods, order cancellations and later arrival penalties, inventory costs and lastly storage costs. All direct and indirect costs have some form of influence on the flow of trade, in their individual and cumulative capacities

2.5.2. Trade Logistics and Transport Costs

The quality of trade logistics is directly linked to cost of transport. An absence of infrastructure or the presence of poor-quality infrastructure can both impede trade by increasing transport costs (Celbis et al., 2014). The cost of moving goods is affected by the distance between the firms located in the exporting and importing country, because keeping all other factors equal, the further the distance between the two parties the more it will cost to transport the goods (Harrigan, 2010). The longer the distance the more fuel and labour hours will be required to transport the good, thus increasing the cost. The type of good being transported also plays a role in determining the overall cost to transport it. Fragile goods will for instance require more spacing and allow for smaller quantities to be transported at a given time. The mass of the good will also have an impact as the heavier the good the more fuel will be required and the less of that good can be transported at a time, as for instance boats have load limits. Domestic transportation networks can impact on the ability of a country's firms to compete in the international market (Coşar & Demir, 2016).

The mode of transport that is used can have a significant effect on the cost and therefore trade flow of goods. Hummels (2007) explains that improvements in the quality of transport services

has influenced the way that producers cope with uncertainty in foreign markets, including how they plan their production and inventory. This is significant, as quality transport services mean that even if transport is slow there is an added degree of reliability and predictability which lets producers better control their cash flow and inventory, which in turn increases their competitiveness. Choosing a mode of transport for goods is often decided by the value-to-weight ratio (Bamber et al., 2014). The lighter and more valuable a good the more likely it is to be transported by air, as opposed to sea. Infrastructure requirements also differ on this basis. The higher the transport cost the less likely trade is to take place. When dealing with agricultural goods, domestic transport and packaging and handling of the agri-food goods prior to export commonly make up the largest portion of the final cost of the good (The World Bank, 2008).

The competitiveness of the transport industry in the exporting and importing countries is influential on the cost to transport a good between firms in two countries. Weak competition amongst transport operators generally leads to higher transport prices being charged. Transport costs are considered to be one of the largest transaction costs in the agricultural supply chain. Development policies target improving transport infrastructure but this doesn't always translate to a true benefit for producers or the end consumer. Regulations and/or policies can be implemented to increase competitiveness in the transport sector. An example is the types of transport rights granted to foreign companies; transport, importation, backhauling, transit, triangular and cabotage rights. The allocation of these transport rights directly impact on the level of competitiveness in the transport industry of a country. The more rights granted the more competitive the industry will be.

Longo and Sekkat (2004) conclude that insufficient infrastructure and mismanagement of economic policies are obstacles specific to intra-African trade, as they do not appear to impact African trade with developed countries. Poor infrastructure and slow border crossing procedures increase the cost of moving the product from the farm to the pack house to the port/border and finally on to the final destination. Trade flow and trade facilitation have a complex relationship, as changes in third-party country's trade facilitation efficiency as well as that of the importer and exporter can all impact the flow of trade (Wilson et al., 2005). Transit time delays throughout the export transport chain, including internal land transportation and its associated costs are particularly impactful to trade. Blonigen and Wilson (2008) list some of the more important infrastructure components for trade as docking facilities in ports; inter-modal connections between road, rail and ports; and the channel depth of harbours. Limão and Venables (2001) found that the relatively low level of trade flows for African countries is directly linked to poor infrastructure. Transport infrastructure can be a domestic supply side limiting factor for trade. In small lesser developed countries, inefficient ocean ports can cause substantial reductions in trade due to congestion (Wilson et al., 2003).

2.5.3. Tariffs and Trade Agreements

Although the impact of trade tariffs and trade agreements on trade are not the pure focus of this study, they do need to be acknowledged due to their considerable influence on trade. Preferential trade agreements are increasingly playing a role in the trade of agricultural goods. Thompson-Lipponen and Greenville (2019) explore whether the treatment of agricultural goods by preferential trading agreements has evolved over time and how this has impacted agricultural distortions. They looked at the aspects of liberalisation that stem from trade agreements including provisions around domestic support and market access and discovered that the majority of agreements do not address government support of agriculture. Their key finding was that

agriculture is progressively being treated more and more like other goods, typically due to the extension of free trade agreements to include agricultural goods. However, variances in the application of rules of origin between different agreements is reducing the potential benefit of reduced tariffs on agricultural goods between member countries. Thompson-Lipponen and Greenville (2019) also note that multilateral rules covering sanitary and phytosanitary standards are becoming more regular inclusions in trade agreements.

Sun and Reed (2010) investigated the trade creation and diversion effects of free trade agreements on agricultural goods; they found that the SADC free trade agreement was one of three free trade agreements globally, that has generated large increases in agricultural trade. Strangely, the increase in SADC trade was largely imports of agricultural goods from 3rd party countries. According to Hallaert et al. (2011) tariffs have a larger impact on the trade flows of landlocked countries than on that of coastal countries. The United Nations (2013) states that the main reason for weak regional trade performance in Africa is that historically the approach to regional integration in Africa has been largely centred around the removal of trade barriers such as tariffs and dealing with trade inhibitors, rather than investing in trade enablers such as transport infrastructure and logistics capabilities. This approach has potentially been to the detriment of overall trade as the development of the productive capacities required for trade has in relative terms been largely ignored. Eliminating trade barriers is not irrelevant, but shouldn't be treated in isolation, as complementary policy measures that boost supply capacity will enhance the effect of the tariff reductions and removals. Jensen and Sandrey (2015) share the view that tariffs alone do not determine trade flows, as their research concludes that the elimination of intra-African agricultural tariffs will stimulate trade and improve welfare for Africa, but that the non-tariff barriers related to trade have a larger impact on trade.

2.5.4. Time and Distance

Distance and time are jointly related concepts, as the further the distance the longer the time it takes to transport goods between two countries, *ceteris paribus*. The further the distance the more likely perishable goods are to expire or become damaged.

Trade costs are a combination of both time and financial dimensions. Time as a factor is essentially comprised of other sub-factors such as the customs process, the transport infrastructure quality, the mode of transport and the distance to the destination. Each of these sub-factors plays a role in determining the overall time taken to transport goods from the exporting firm to the importing firm and in turn, the time taken to deliver goods impacts on the cost to complete their transportation.

Djankov et al. (2010) calculated that it would take "116 days to move an export container from a factory in Bangui (Central African Republic) to the nearest port and fulfil all the customs, administrative, and port requirements to load the cargo onto a ship", and that it would take "71 days to do so from Ouagadougou (Burkina Faso)", but only 16 days from Port Louis (Mauritius). This shows the massive variability in the time taken to ship goods from different cities across the African continent. The findings of the study were that each day a product is delayed prior to shipment, will reduce export trade flows by 1%, which is the equivalent of adding 70 kilometres onto the distance of the total trip (Djankov et al., 2010). An example from Djankov, et al. (2010) that illustrates the magnitude of this, is that if Uganda could reduce the time taken to get goods from the factory onto the ship from 58 days to 27 days it would be the equivalent of reducing

distance by 2200 kilometres which could lead to trade volumes increasing by up to 37%. There is an inverse relationship between time and trade volumes.

2.5.5. Standards

Public and private standards are growing in importance as market access barriers for international trade (Schuster & Maertens, 2015). These standards can relate to the governance of product characteristics, production processes, processing methods and distribution choices. The standard of food has become increasingly identified in literature as a non-tariff barrier to trade. Swinnen (2016) states that agreements such as those of the World Trade Organization (WTO) have led to a lessening of global trade tariffs. There is an argument in literature that the removal of trade tariffs has driven some countries to increase their standards as an alternative way of protecting their domestic market from cheap imports. Standards are instituted by governments and various bodies of authority for both the production and trade of food; these standards cover ethics, quality, sanitation and environmental impact. New, more stringent standards are continuously being introduced to protect the end consumer. When it comes to trade, standards can create welfare gains, but can also involve rent redistribution. The result of this is that various groups have the incentive to lobby for the standards to be set at the level that best suits them.

Public authorities set public standards which typically address safety and quality issues relating to food that will affect the health of consumers or the spread of disease. These are generally strictly monitored standards that are regulated through legal inspections that are enforceable by law (Schuster & Maertens, 2015). In light of the COVID-19 pandemic, it is very likely that public standards will become more important in the context of trade of food and other agricultural goods. There is a strong need for these new COVID-19 sanitary related standards to be science based, as unnecessary restrictions could burden exporters and add unnecessary costs to trade.

Private companies and non-governmental agencies can set private standards. Private standards tend not be mandatory, but greatly affect the marketability of an exporters produce in a country, where the private standards are widely promoted by importing firms. These standards typically cover the environmental impact in the production of the food and additional levels of quality requirements. Third party certification and audits are conventional controls for private standards. Schuster and Maertens (2015) could not find evidence of private standards stimulating trade but there was also no evidence of private standards in their case impacting on a firm’s ability to export. This however, was a case study specific to asparagus and cannot necessarily be used as an argument for all agricultural goods in all regions. In fact, Henson and Humphrey (2010) conclude that it is difficult to make generalisations relating to the impact of private standards on agricultural trade based on the variability in the nature of private standards. Private standards can be either unique to a single importing firm or collective for an industry; private standards can be used to increase product differentiation or to manage risk; private standards can be linked to brands or can be invisible to the end consumer; private standards can be set at a national or international level (Henson & Humphrey, 2010).

European markets can be particularly stringent. Standards are supposed to be homogenous across products entering a market, irrespective of their origin which means that the impact should be fairly similar across trading partners, assuming access to capital is equal (Hoekman & Nicita, 2011), but it is sometimes difficult for developing and poorer countries to comply with such stringent standards. They are at a disadvantage to developed nations, where agricultural inputs

are much more readily available. High levels of standards can result in the exclusion of smaller producers who cannot afford the costs incurred to comply with some of the standards (Swinnen, 2016). A lack of financial capital in developing countries is seen as a disadvantage in getting the required certifications for gaining entry to certain import markets, as smaller scale exporters will thus be cut out of the export value chain. Propensity matching has been used to prove that firms that have been certified for various standards through a third-party auditor are able to earn higher export revenues. It does however appear that as more firms become certified so the benefit of certification reduces (Henson et al., 2011). Asymmetric information is also a problem in developing markets, when it comes to certification and standards requirements to export to a developed country (Schuster & Maertens, 2015). Trade between countries of a similar level of development often has less issues with asymmetric information and standards are of similar level.

It is important to emphasize that although standards can be protectionist, they are not always protectionist. High standards can lead to increased willingness to pay by importers and thus exporters are able to receive a higher price for their goods. Standards can actually be catalysts for developing countries participation in trade by allaying the concern of consumers.

2.5.6. Customs

A high-quality customs environment is highly consistent with transparent procedures, regular working hours, adequate staff complements, and increasingly digitised processes. Customs agencies process international trade transactions and substantially contribute to the ease or difficulty of doing business in a particular country. Customs procedures include the valuation of goods and classification of goods following inspections and document checks (Liu & Yue, 2013). These processes can be highly inefficiently managed in certain countries, some of which are criticised for deliberately delaying processes in order to protect local producers or elicit bribes. In some instances, customs delays can lead to exporting firms ceasing to export to certain markets that are particularly difficult to process their goods through (Martincus et al., 2015). Delays in customs have been found to be more detrimental to exporters, when delivering time sensitive goods to new customers (Martincus et al., 2015).

Laborious administrative procedures and inefficient customs processes are the leading non-tariff barriers in terms of restricting trade across borders. Bureaucratic delays vary vastly across countries. It can become burdensome when officials use documentation to extract bribes. Lengthy documentation procedures can be less of a problem when the process is predictable and can be planned for in advance. Slow reliable ports are preferable or those where legitimate payments can be made for faster service. Extended delays at borders can considerably reduce the quality and therefore value of perishable agricultural products (Liu & Yue, 2013). Conversely, when customs processes improve and delays are less frequent, then the trade flow of agricultural goods increases. Freund and Rocha (2010) specifically look at the effects of transit, documentation and ports and customs delays on African exports. The conclusion that is drawn in their study is that transit delays have the most significant (economically and statistically) impact on African exports. A one day saving in inland travel time was found to lead to a 7% increase in exports – a different way to explain this is that a single day of added inland travel time is the equivalent of a 1.5% increase in all importing country tariffs. Korinek and Sourdin (2011) established that although improvements in the administrative components of border processes positively impacts both exports and imports, it does have a more substantial influence on imports.

COVID-19 has resulted in customs processes in many countries, both African and non-African, temporarily becoming more complicated and less efficient than usual. Extra checks at borders are creating delays and impacting on the timely delivery of perishable goods. The other reason for slower processing at borders is that in many places the number of inspectors on site have been reduced to ensure social distancing measures are adhered to.

2.5.7. Demand and Consumer Preferences / Trade Complementarity

Consumer demand certainly influences trade volumes. Over the last 20 years, agricultural exports have diversified, and fresh high value agricultural products and processed agricultural goods have grown in demand (The World Bank, 2008). These changes in demand are largely driven by consumer tastes and preferences, which are ever evolving. Supply chain technologies and improved transport have allowed exporters to meet these changing tastes, as technology allows perishable fresh agricultural goods to be transported over greater distances with less deterioration of quality.

Consumers in Africa have gradually started tending away from traditional staples, as preferences change in conjunction with urbanisation and an increase in household income. The consumption patterns are moving away from sorghum, maize, millet and tubers towards meat, wheat and rice (Nigatu et al., 2017). Rice was previously viewed in Africa as an exotic luxury but has increasingly become a staple for a growing middle class to the point that annual per capita rice consumption exceeds 60 kilograms and is higher than the global average (Nigatu et al., 2017). Nigeria, Cote d'Ivoire and Madagascar are the three largest rice consuming countries in Africa. Nigeria and Madagascar are not only rice consuming but also rice producing countries, albeit with limited expansion. A clear example of a change in consumer preference can be seen with West African rice. Import dependency on rice in West Africa increased due to local demand outstripping local supply. The result of which is that the urban consumer in West Africa has developed a bias towards the imported rice, according to Demont et al. (2017). The imported rice meets Asian export quality standards and across 5 West African urban markets Demont et al. (2017) are able to demonstrate that as consumers become accustomed to the characteristics of the imported rice, the more difficult it is for domestic rice to compete, especially in proximity to ports. This is interesting because although the initial demand for imported rice was due to local supply not being sufficient, the consumers' preference has evolved to the point that imported rice is preferred due to its taste and not just because of its availability.

Africa is widely believed to be dependent on food imports but this is not the case. Africa's largest import of agricultural good by value is wheat; $10 billion worth was imported in 2018. Wheat has become a popular staple food in Africa despite not being a crop well suited to growing on the majority of the continent. African consumers' preference is tending towards wheat over rice and maize, which means that demand for wheat is outstripping local supply. Imports are thus necessary to meet local demand. This is indicative not of the fact that Africa cannot feed itself but rather that changing consumer preferences are leading to demand that cannot be met through local production due to limiting factors such as climate. South Africa, which is a wheat producer, is an example of this. South Africa imports large quantities of wheat to close the gap between domestic consumption and production of wheat (McDonald et al., 2008); $414 million of wheat was imported in 2018 (ITC, 2019). Egypt is actually the largest importer of wheat in the world, having imported $2.6 billion of wheat in 2018 (ITC, 2019). Looking beyond staples, consumer's

preference for staples such as wheat and rice are being replaced by higher value products such as meat.

2.5.8. Local Production

Smaller economies typically export less in absolute terms than larger economies (Hummels & Klenow, 2005). International trade models largely focus on goods that can be produced in all countries. The reality is that not all goods are made in all countries, as certain goods have a requisite for a specific factor that is not common across countries. Non-competitive imports are those goods which the importing country cannot produce in sufficient levels to meet demand (Gray, 1986). Pure non-competitive goods are those which simply cannot be produced in the importing country and thus all local demand for that good is serviced by imports. Climatic conditions and natural endowments are typically the requisites that control pure non-competitive goods but proprietary technology and industry specific human capital can also be limiting factors for production. Agricultural examples include rice in Iceland and grapes in Scotland. Hybrid non-competitive goods fill the gap between local demand and supply, where there is limited local supply but imports are required to meet local demand. Examples are typically agricultural staples that have production limited due to some climatic constraint in densely populated countries. Trade in non-competitive goods generate greater per unit gains than other goods (Gray 1986).

2.5.9. Cultural and Social Similarities

A common language variable is often used in bilateral trade flow studies and is considered to be one of the important drivers of bilateral trade (Egger & Toubal, 2018). The reason for this is that language is a gauge of how easily clear communication can be achieved between exporting and importing firms thus enabling or inhibiting the transaction. Melitz and Toubal's (2014) research finds that over a sample of countries, the ability to communicate is of more importance for international trade than what cultural similarities are. Their study re-affirms the logical assumption that similarities in language eases communication and increases the ability for firms in different countries to transact. Although less important than language, religion can also play a role, as having the same social norms can smoothen business transactions and lead to increased trade by avoiding miscommunications. Head et al. (2010) did research on how trade changes following independence from colonisation. The results were that after 40 years, trade with the historical coloniser will have contracted by as much as 65% and that trade between countries that had a common coloniser also decreased by a similar percent. Additionally, trade between unrelated third-party countries and previously colonised countries has declined by roughly 20%, which indicates that overall there has been a deterioration in trading capital following independence (Head et al., 2010). Aker et al. (2014) found in their study that when traders have a common ethnicity, the associated transaction costs of communication and provision of credit are reduced. Ethnic ties, trust, and the ability to communicate directly all lead to increased trade between firms in different countries.

2.5.10. Institutional Quality, Political Stability and Governance

Political stability and corruption are both factors that impact bilateral trade (Inançli & Addi, 2019). Violence and political instability can compromise trade relations. Muhammad et al. (2013) investigated the consequences of the violence following the Kenyan election in 2007 and how it

impacted the cut flower trade between Kenya and the European Union. The finding was that Kenya lost roughly 33 million euros in trade that otherwise would have taken place with the European Union. It appears that even a short spate of violence in an exporting country can degrade importer's confidence that the exporter can deliver as promised. Importers will often choose to use alternative exporters, even when stability has returned to the exporting country. The risk averseness of the importer largely determines how long it takes for the importer's perception of the exporter's stability to change.

Álvarez et al. (2018) examined whether institutional quality impacts bilateral trade. They used a sectoral trade framework and deduced that not only do the institutional conditions in the importing country matter, but so does the institutional distance between the exporting and importing countries. High quality institutions inadvertently drive trade by enhancing the competitiveness of markets, limiting the influence of individual firms and reducing rent seeking activity.

2.5.11. COVID-19 Pandemic

The COVID-19 pandemic is an ongoing global challenge and there is much uncertainty around how long it will continue to have a significant impact on economies. Its impact might be transient but it has already been likened to and described as worse than the economic meltdown in 2008 (Meyer, 2020). There was initially concern that a lack of confidence in the international market could spark restrictions on exports and panic buying by importers, neither of which benefits the countries involved. There were a few examples of this but largely panic policy decisions were avoided. Vietnam temporarily suspended their exports of rice which caused a temporary shortage and increase in price of rice globally, but the export ban was lifted swiftly (Meyer, 2020; Purchase, 2020). Stock of agricultural goods globally is sufficient, but there is a possibility that specific food supply chains may be further interrupted due to insufficient labour availability, heightened public standards for goods and constraints in the logistics ecosystem leading to delays and increased costs.

Thus far the impact of COVID-19 on the agricultural sector in Africa has been fairly limited, due to a couple of mitigating factors (Pais et al., 2020). There has been good rainfall recorded during early 2020 and large harvests are expected, particularly for maize in South Africa. West African countries were fortunate to have completed the majority of their planting season before lock down measures were implemented and in most African countries agriculture and food production has been classified as an essential service and thus been able to continue operating. The exception to this is the wine industry in South Africa which suffered significantly during an initial hard lockdown. Vinpro, a South African wine industry body reported that the initial ban on exports for 5 weeks and local sales for 9 weeks, could result in more than 80 wineries and 350 wine grape producers closing their business. These closures could in turn result in the loss of 21 000 jobs throughout the value chain within the next year. These predictions were made before the ban on local sales was temporarily re-instated for an additional period. The sale of liquor is no longer banned but the COVID-19 lockdown measures could have long lasting effects on the South African wine industry and the competitiveness of its exports.

The transport of perishable goods has proved challenging during the COVID-19 outbreak due to unpredictable delays caused by logistics bottle necks and/or reduced efficiency at border checks. New measures that have been implemented to reduce the spread of COVID-19 are inadvertently creating delays and disruptions within the transport and logistics networks (OECD, 2020) . The

closure of borders and additional requirements at open borders are increasing congestion (East African Business Council, 2020). The result of these kinds of delays is that perishable products in transit are ruining before they reach their final destination. At customs checkpoints social distancing has also reduced the number of staff available for inspections, which means that border clearance is taking longer than it previously did.

The biggest disruption thus far in terms of agricultural trade appears to have been to the trade of high value agricultural goods where there is a reliance on air transport. Air freight has become significantly more costly with the grounding of passenger aircraft and flight cancellations. Many agricultural goods that are transported by air are actually shipped on commercial passenger flights (OECD, 2020). High value commodities have been affected from a demand perspective as well. The closure of restaurants and hotels in various countries has meant cancellations in orders for fresh foods and potential wastage. Despite this, food demand is normally inelastic and the impact of COVID-19 on overall consumption should be limited, although consumers' diet patterns will probably change. Loss of income in poorer developing countries, however will have more marked changes in consumption and potentially even lead to reduced total consumption due to reductions in personal income.

COVID-19 has meant a restriction on the movement of people in an effort to curb the spread of the virus (OECD, 2020). This in turn has caused labour shortage issues for both farmers and food processors, as changes in labour availability impact on production (FAO, 2020). Agriculture is a sector that relies on the presence of people and it is not possible for employees to work from home. The labour shortage occurs due to employees being unable to travel to work (government regulations), employees falling ill and employees having to self-isolate when they have potentially been exposed to the virus. Examples of this occurring, include the temporary closures of large meat plants abattoirs in Brazil, Canada and the United States due to COVID-19 outbreaks amongst staff. Input shortages are predicted to be a medium-term problem that will be experienced by the agricultural sector. Fertiliser is the main input that is expected to be impacted by COVID-19 (OECD, 2020). A shortage of inputs will reduce productive capabilities and possibly push up production costs. Production costs may also increase due to the implementation of social distancing measures which reduce efficiency. From a livestock perspective there has been reduced access to animal feeds and slaughter houses have been unable to cope with demand as their capacity has been reduced due to social distancing constraints and labour shortages (FAO, 2020).

Africa's agriculture and food systems are still mostly operational, at the time of writing, and have not been dramatically impacted. However, there is the possibility that larger issues stemming from COVID-19 will arise in the medium to long term and have some form of negative impact on trade of agricultural goods.

2.6. Conclusion

Chapter 2 began with an overview of international trade theory. It was established that firms in different countries trade when specialization takes place. Through specialisation firms are able to maximise comparative advantages in various goods and services. The Chapter then progressed to discuss Jacob Viner's customs unions theory and trade creation and diversion. This led into background on Africa's current economic integration and trade agreements. It is evident that there

is a renewed commitment on the African continent to build regional integration, which is exemplified by the implementation of the African Continental Free Trade Area (AfCFTA) agreement. Intra-African trade is an enabler for regional integration and economic growth in Africa. Intra-African trade is vital for economic integration and development within the greater region, but it is not of equal importance to all economies.

Trade trends were illustrated and it was determined that in 2018, cane and beet sugar was the agricultural commodity by value that was most traded between African countries. The current African production and export structures are narrow and continue to have a high dependence on primary hard commodities. Intra-African trade is low for agricultural goods compared to other regions, despite the fact that there is currently a strong drive towards regional integration in Africa. This is exemplified by the implementation of the AfCFTA, but the lag is due to many years of uncoordinated effort across the African continent, which is evidenced by various overlaps of the regional economic communities. Many of these regional economic communities despite having been in existence for over 20 years have little in terms of real progress to show. SACU is the one preferential trade agreement that has genuinely had an impact on trade.

It was crucial to cover international trade theory up front in order to establish the required foundation to understand the theory of the gravity model, which is addressed in Chapter 4. Regional trade agreements were discussed so that the importance of including a trade agreement variable in the gravity model is understood by the reader, when reading Chapter 5. The section on trade trends was included to ensure that the reader has proper context to the level of agricultural trade currently taking place in Africa and to illustrate the scope for the growth of trade.

A short summary was provided on what differentiates the trade of agricultural goods from other goods; namely seasonality, perishability and a reliance on climate. The relevance of these characteristics is that the transport time is likely to play a larger role in determining the bilateral trade of agricultural goods than what it will for other goods.

Factors that influence trade were then discussed, as exports of agricultural goods have the potential to be sources of pro-poor growth in Africa (Swinnen, 2016), but there are various factors that currently inhibit further intra-African trade. Transport infrastructure and customs efficiency amongst other components of trade logistics are the main culprits of time delays, which deter trade. Tariff removal and reductions in non-tariff barriers, along with decreases in time in transit costs through improved infrastructure and border efficiencies could cumulatively stimulate significant trade gains for Africa (Jensen & Sandrey, 2015). Tariffs and non-tariff barriers such as quality standards are easier costs to reduce, whereas, freight and transportation costs are more difficult costs to zero. The latter elements of improved infrastructure and border efficiencies is what will be investigated in the next chapter. A brief note was made on the impact of the COVID-19 pandemic on agriculture, although predictions on the future impact of COVID-19 on trade are difficult to make due to the high levels of uncertainty in the market.

The key reason for discussing factors that influence trade is to introduce the idea of variables other than trade logistics than can also be included in the gravity model. It was important to show that although trade logistics is the factor that is the focus of this study, there are other factors that can also impact trade levels.

Clearly a major part of the challenge in increasing intra-African trade, includes moving agricultural goods from the farm gate to ship more efficiently and then from there to the consumer or importing firm. Chapter 3 will review the role that trade logistics play in the trade of goods and what the current state of trade logistics is in Africa.

3. Trade Logistics

3.1. Introduction

In Chapter 2, the broad topic of trade was discussed, including current trends across the African continent and the state of the existing preferential trade agreements. The various factors that influence volumes of trade and trading partners were outlined and then the chapter was closed out by discussing the characteristics of agricultural goods that make them different from other goods in the course of trade.

Transport costs and by inference the quality of trade logistics were highlighted as a major factor that impacts on trade volumes and the choice of trading partners. The study thus continues by investigating trade logistics. Chapter 3 defines trade logistics and then contextualizes trade logistics from an African perspective. The African context of trade logistics is broken down into background information; a deep dive into transportation infrastructure; a brief discussion around the customs environment and then some notes on investment into infrastructure on the African continent. The last section of the chapter outlines three different measures of logistics performance and interprets what they suggest about trade logistics in Africa.

3.2. The Definition and Role of Trade Logistics

Korinek and Sourdin (2011) provide a simple definition of trade logistics: the range of services and processes required to move goods from one country to another. Trade logistics can be split into three main categories: transport infrastructure, service provision and cross-border trade facilitation. Arvis et al. (2018) elaborate to say that logistics encompasses a variety of activities such as transportation, warehousing, brokerage, data and information management, express delivery, and terminal operations. Elements of trade facilitation can also be split into “hard” and “soft” categories. The hard category includes physical tangible infrastructure, whereas the soft category refers to less tangible aspects such as the ease of doing business, customs efficiency, transparency and other institutional aspects (Portugal-Perez & Wilson, 2012). A unique aspect of logistics is the split of public and private contributions. Infrastructure is predominantly built and maintained by governments and border controls are managed by government, but service providers are largely private firms.

Logistics performance for the purpose of this study has been defined as the level and quality of trade facilitation and transport infrastructure which determines the ease with which goods can be moved out of and into a country. Using Arvis et al.’s (2018) performance terminology, countries can be classified as logistics “unfriendly”, “partial performers”, “consistent performers”, and “logistics friendly”. A logistics friendly country is on where there is a reliable supply chain and the service delivery is predictable. Reliability is more important than speed when it comes to trade, as it allows firms to plan and improve control of inventories on both ends. Freund and Rocha (2010) succinctly sum the concept up: “good logistics reduce trade costs, but supply chains are only as strong as their weakest link”. Developing countries that are serious about economic development through trade, need to identify the weakest link in their logistics supply chain and then endeavour to improve that link through the necessary means, whether that be through policy

or investment. Figure 3-1 illustrates where logistics fits into the relationship between trade and economic growth.

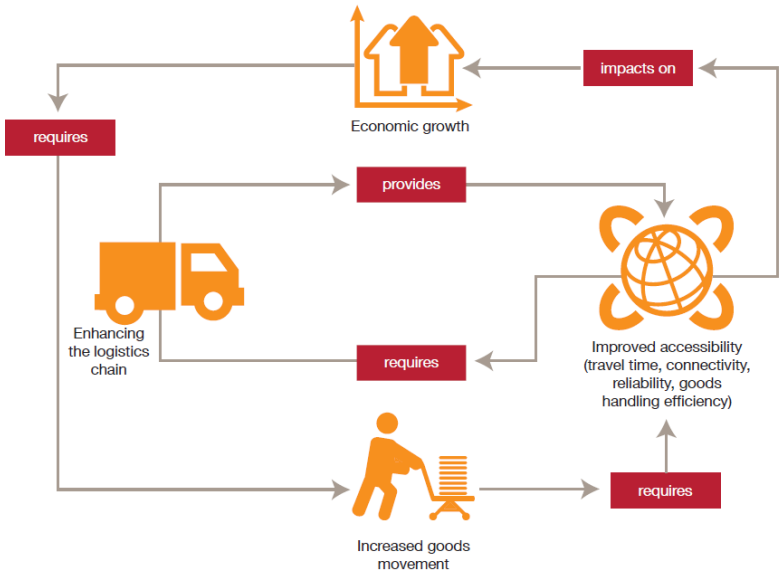


Figure 3-1 Links between an Enhanced Logistics Chain and Economic Growth

Source: Botes et al. (2018)

The main role of trade logistics is to get goods from one place to another as quickly, cheaply, safely and efficiently as possible. According to Bottasso et al. (2018) logistics is key in creating links between different transport networks and strengthening international production chains. This makes trade logistics the backbone of any economy, as without it no goods will be traded, and little foreign exchange can be earned. The demand for trade logistics is derived purely from the demand for goods. Overall country competitiveness is strongly linked to the quality of its transport, freight and logistics industry (Bensassi et al., 2015). High quality logistics services can improve the competitiveness of a country's exports by reducing the monetary and time costs involved in transportation; this has been found to be especially true for countries that are located at great distances from the world's major markets (Korinek & Sourdin, 2011). Trade logistics has a key role to play in the modern globalized economy. Supply chains are continuously becoming more complex and integrated to meet fast changing consumer demands.

The trade process can be broken down into the series of events starting from the producer in the exporting country until the goods are received by the retailer in the importing country (Figure 3-2). Domestic transport involves the consolidation of goods from producers before they are loaded onto either a truck or train which then delivers the goods to an export gateway where the goods are then unloaded. At the export gateway the goods are often stored and cleared for export before being loaded onto another mode of transport. The goods are then transported from one country to another. On arrival the goods are unloaded and cleared for import before being transported to a local transport mode for delivery to a wholesaler or distributor. The goods are then taken to a distribution centre before being transported to the end retailer.

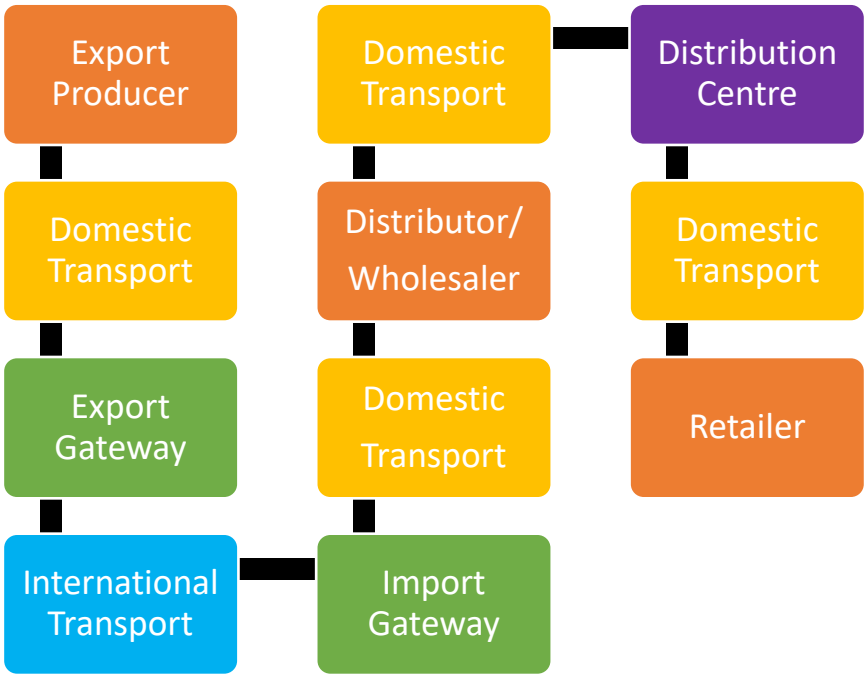


Figure 3-2 The Typical Export Process

Source: Adapted from The World Bank (2010)

The number of private logistics operators and their specialization has a direct bearing on the ability of firms within a country to implement their export strategies. High transaction costs in African trade are not singly linked to tariffs. Rather they are a result of the relationship between the existing infrastructure or lack there-of, geographical locations (distances between seller and buyer), and policies across the trading countries. As Christ and Ferrantino (2011) point out, inconsistent transit time adds an uncertainty cost to trading firms. Uncertainty costs include unplanned for inventory costs and even refunds when the total delivery time to reach the end consumer reaches an unacceptable length of time. Increased costs for producers, time delays and high levels of uncertainty all combine to determine the ability of a country's firms to participate in global trade. This applies to all agricultural goods, whether primary, semi-processed or processed.

Improved trade logistics reduces congestion at various points in the chain of trade, which reduces the time to move goods from one place to another. This creates direct efficiency gains for firms, as they benefit from cheaper and more reliable freight services as well as reduced delivery costs. This in turn incentivizes firms to re-organize and reduce their inventories to "just-in-time" levels, which is particularly useful for agricultural goods exporters due to the perishable nature of some of their products. Good trade logistics also enable firms to consolidate their distribution warehouses, thus minimizing their fixed costs.

Improved transport at lower costs increases accessibility between segments of the value chain, including end consumers, distributors, producers and input suppliers. This includes opening access to markets for previously unreached rural areas. Market expansion is an outcome of improving trade logistics, as it makes it easier and cheaper to reach further afield to sell one's goods. A larger market allows for increased scale of production by an industry, which brings about the possibility of leveraging off economies of scale and increased efficiency gains. Efficiency gains through trade are a pre-requisite for specialisation to take place. Both inter-regional and intra-

regional specialization are stimulated by cheaper and more efficient transport (Lakshmanan & Anderson, 2007). Local specialisation drives the competitiveness of an industry. A competitive environment drives down costs, and this holds true for logistics and transport (Moïsé & Le Bris, 2013). In a given country, the larger the number of ports, service providers and modes of transport available in the market, the lower the logistics costs should be for exporting firms.

3.3. The African Context

This sub-section of the Chapter specifically looks at the African continent and the prevailing conditions that are important in terms of trade logistics quality and capability.

3.3.1. Background

Despite the involvement of various African governments and the private sector in driving regional integration, continental integration has remained comparatively low in Africa relative to the rest of the world. From a trade perspective this has already been discussed in Chapter 2. This section of Chapter 3 will provide background on why Africa has inadequate infrastructure and relatively inefficient logistics to date.

Africa is a large continent of 30 million km^2 comprising of 54 countries. The connectivity levels between these countries appears low when considering the size of Africa and the relatively low road density but when the continent's population and income is taken into consideration then the existing road density starts to look decent. For perspective, as of 2008, Mozambique, Madagascar, Malawi and Niger's asset values of their road networks exceeded 30% of their GDP value (Gwilliam et al., 2008). This statistic illustrates the scale of the maintenance affordability problem faced by African countries. Terrain also provides certain challenges for countries with respect to transport, freight and logistics infrastructure. Extreme conditions in countries such as the hot humid rainforests of the Democratic Republic of Congo and the large deserts of Mauritania make it tough to build bridges, dig tunnels and expand and maintain road and railway networks. It is important, however, to note that even countries with less extreme terrain face struggles with regard to their infrastructure maturity. Almost a third of African countries are landlocked. Landlocked countries are generally at a disadvantage due to their lack of direct access to maritime transport and face higher trading costs and longer transport times than coastal countries. The main trade challenge for landlocked countries is that they need to transport their goods through adjacent countries before they can access maritime transport – this means that a heavy reliance is placed on overland transport. Moore (2018) found that, ceteris paribus, on average, landlocked countries during the period of 2005-2014 traded 27%-41% less than countries that are not landlocked. Further to this, developing countries are more heavily penalized for being landlocked than developed higher income countries. Trade constraints associated with landlocked developing countries include more borders to cross, longer border delays, poorer quality logistics and underdeveloped infrastructure. These constraints are frequently attributed to the inefficiency of inland trade corridors.

Rent seeking activities linked to trade and logistics in Africa are pervasive, from unofficial roadblocks, to bribery of customs officials, and corrupt officials operating in the industry. These are strongly inhibiting factors to trade, as importers and exporters face higher risks (Moïsé & Le Bris, 2013), and higher risk means that insurance premiums for trading in these countries will be

higher than elsewhere. Transport and insurance costs as a percentage of trade value are higher in Sub-Saharan Africa than other developing regions of the world (Figure 3-3). In fact, coastal Sub-Saharan African countries are even worse off than landlocked countries in other developing regions. Sub-Saharan countries make up over 80% of African countries so an inference can be made from De Bod and Havenga's (2010) work that Africa has the highest transport and insurance costs globally as a percentage of trade value.

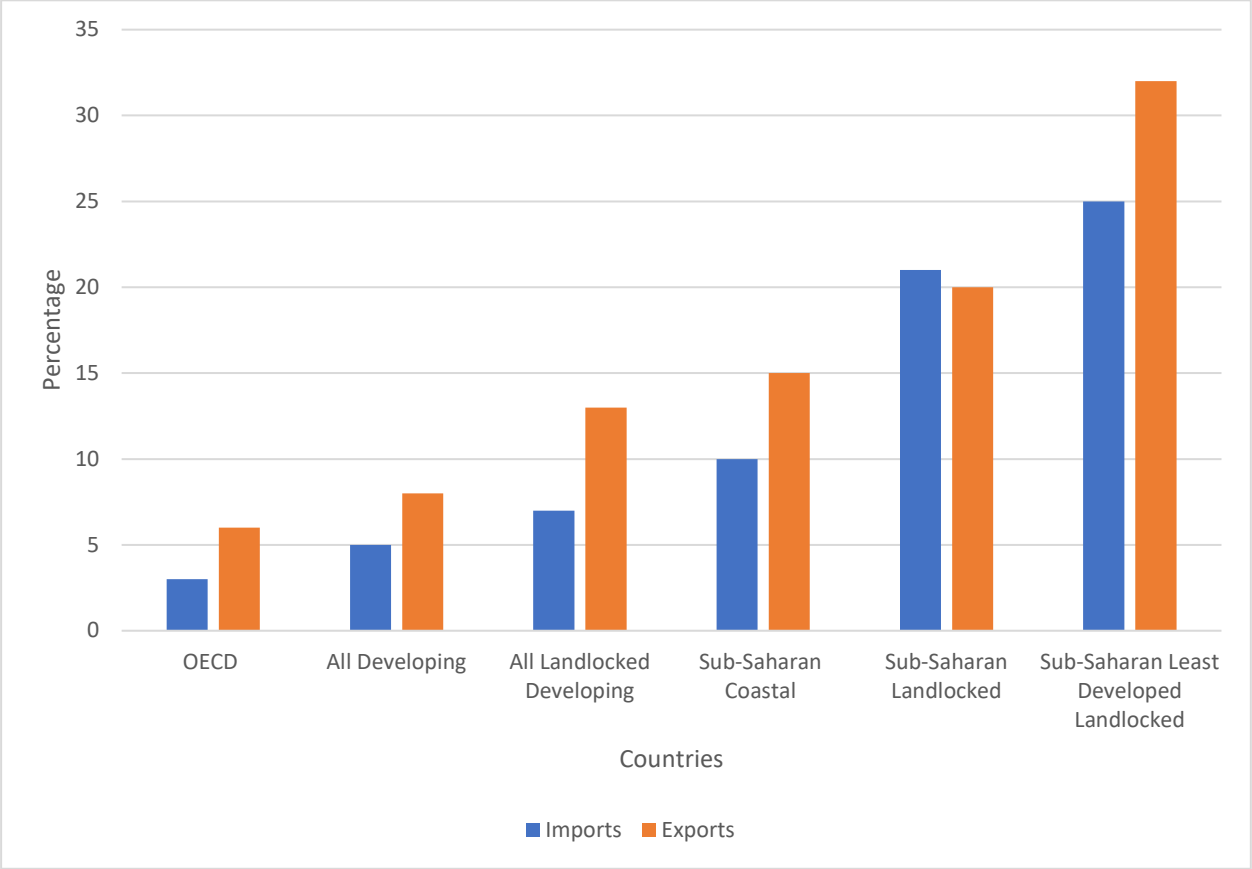


Figure 3-3 Transport and Insurance Costs as a Percentage of Trade Value

Source: Adapted from De Bod and Havenga (2010)

3.3.2. Trade Corridors

Developmental regionalism is an approach to the integration and co-operation of a group of countries in the same geographical area. Developmental regionalism places emphasis on the promotion of intra-regional trade, which can be achieved through different mechanisms (UN, 2013). This includes the building of regional transport infrastructure such as hub ports, roads and railroads to allow for better connectivity; the designing of policies to accelerate industrial development; joint research and development projects; and increased investment. The quantity and quality of transport infrastructure in a country is linked to international trade flows and the level of connectivity within a region (Bottasso et al., 2018). Trade logistics falls into a range of items that are addressed through developmental regionalism.

Trade corridors are designed to facilitate trade throughout a region. The original trade corridors in Africa were designed as 'extraction' corridors to move mined commodities from the inland

mines to seaports. The primary focus of modern corridor-based initiatives is the improvement of inland transport networks and their linkage to higher volume ports. The inland transport networks are comprised of road infrastructure and to a lesser but growing degree rail infrastructure. A typical transportation corridor consists of rail, road, border posts, and seaport and terminal facilities. The core purpose of trade corridors is to increase connectivity between countries, thus promoting regional trade and development. Figure 3-4 shows the main transport and trade corridors present in West, East and Southern Africa, as of 2018.

The Maputo Development Corridor is an example of the development of regional transport infrastructure in Southern Africa. The purpose of the Maputo Development Corridor is to connect the landlocked regions of Eswatini, Limpopo and Gauteng to the Port of Maputo in Mozambique (Maputo Corridor Logistics Initiative, 2016). Hanaoka et al. (2019) speaks about two major multi-country trade corridors in East Africa, namely the “Northern corridor” and the “Central corridor”. The port of Mombasa in Kenya serves as the main gateway seaport for the Northern corridor, whereas Dar es Salaam in Tanzania acts as the main gateway seaport for the Central corridor. The two ports compete against each other to attract trade traffic from the hinterland. Uganda and South Sudan favour Mombasa, but Zambia tends to use Dar es Salaam. The Democratic Republic of Congo and Rwanda use both ports to facilitate their trade of goods. The cross-border corridors that link these lesser developed landlocked countries to the ports are particularly important in facilitating trade. The Northern trade corridors include both rail and road as modes of transport linking Burundi to Kenya, while passing through Uganda and Rwanda.

The African Development Bank (AfDB) Group has become particularly involved in funding cross border road corridors. Their report provides a set of outcomes for the projects that they have been involved in. One such project is the Nacala corridor. According to the AfDB 2019 report, travel time along sections of the Nacala corridor that have been funded by the AfDB have resulted in the cumulative travel time being cut from 30 hours to 15 hours; truck’s waiting time at the Malawi border crossing has reduced from 12 hours to a mere 3 hours. In addition to these time savings, vehicle operating costs have been reduced by 36% in Mozambique and 20% Malawi.

In a certain sense, transport corridors are a public good. They are controlled by the governments of the countries through which they pass. The main purpose of a transport corridor is to generate new trade opportunities and to heighten competitiveness. There are network effects with trade corridors. What this means is that a certain number of users are required in order to reduce the costs for all users of the corridor. Essentially scaled usage is key to successful trade corridor project. If there are not enough users then investment into a trade corridor can become an expensive regret, as the costs of using and maintaining it end up costing users. All the countries involved need to be in agreement for it to be a sustainable solution.

Figure 3-4 Diagram of Trade Corridors in East, West and Southern Africa

Source: Botes et al. (2018)

3.3.3. Transportation Modes and Infrastructure

What impact does good quality infrastructure have on trade and why? Good quality infrastructure can drive higher levels of productivity and push down costs for firms, while increasing international trade volumes (Wessel, 2019).

Africa's infrastructure has historically been constructed to enable trade with the rest of the world, rather than with itself (Bonfatti & Poelhekke, 2017). The geographical location of mines can influence transport infrastructure distribution within a country. In resource rich, mineral exporting countries, mines are normally connected directly by transport infrastructure, such as railways to the coast. A transportation network that has an interior to coast shape can be seen as biasing trade costs so that it is cheaper to trade with overseas countries than with neighbouring countries. African railways are distinctly interior-to-coast shaped. The distribution and linking of railways and roads was originally constructed as a result of these countries being reliant on their ability to export the outputs of natural resources. It is not limited to railways, as roads in Africa also tend to be interior to coast shaped, with limited links to connect to neighbouring counties. The roads that do exist are there to connect the interior of a landlocked country to the coast. As much as this is a re-occurring pattern, there are obviously plenty of cases where this does not hold true. Ghana and Guinea are resource rich countries with more heavily shaped links than Kenya or Namibia. Zambia and Zimbabwe are well linked to the coast but Uganda is not. The development pattern

of African infrastructure has very likely influenced relative trade costs in Africa and thus impacted on intra-regional trade volumes.

Intra-continental trade should in theory be cheaper than inter-continental trade in terms of transport costs, as distances will often be shorter, and insurance is typically less expensive by about 2-4%, according to the OECD (Export-Import Bank of India, 2018). This is supportive of the strategy to grow intra-African trade and highlights the fact that improved transport infrastructure is required for African countries to properly reap the benefits of intra-regional and intra-continental trade. Currently, underdeveloped and ill-maintained transport infrastructure increases the cost of goods traded amongst African countries by up to 40% (Export-Import Bank of India, 2018). Not all regions and countries have the same transport costs. Small island nations and landlocked countries, especially those that are developing economies, incur the highest transport costs. Lower income countries are also at a disadvantage in terms of the costs they face for transportation. UNCTAD has calculated that in 2016 the world average for transport costs was 15% of the value of imports, whereas the averages for lesser developed countries, landlocked developing countries, and small developing island countries were respectively 21%, 19% and 22% (Export-Import Bank of India, 2018). Wessel (2019) is able to show that an improvement in infrastructure has a greater effect on export volumes than on import volumes.

Agricultural goods are transported by three main types of transportation, namely by bulk, by container and by air freight. Bulk transportation is accomplished on ships and barges, whereas container transport can be performed by boat, rail, truck or other overland transport options. Air freight is self-explanatory and is facilitated by aircraft. Certain agricultural goods are better suited to different types of transport; cereal and oilseeds are appropriate for bulk transport but typically meat and dairy products require continuous refrigeration and thus are moved in refrigerated containers onboard trucks (OECD, 2020). Only agricultural goods that are perishable and have a high value to weight ratio are transported by air, often in the cargo hold of passenger aircraft (OECD, 2020).

Across all modes of transport, the quality and cost of logistics services as well as the available physical infrastructure is as important in determining the transit time of goods, as the border related trade facilitation processes such as customs (Moïsé & Le Bris, 2013). Hard infrastructure is transversal to all stages of the international trade supply chain. Infrastructure and logistics are integral to ensuring an efficient supply chain from the farm gate all the way to the end consumer (Moïsé & Le Bris, 2013). Trade related infrastructure includes: ports, airports, roads, railways, warehousing, transloading spaces, and information and communications technology (ICT). ICT is an important facilitator of information flows, which makes it easier for businesses to do cross-border deals.

3.3.3.1. Ports and Maritime Trade

The principal mode of transport for the international trade of goods is maritime (Moïsé & Le Bris, 2013; Bottasso et al., 2018; Munim & Schramm, 2018). Portugal-Perez and Wilson (2012), Celbis et al. (2014), Olarreaga (2016) and Botasso et al. (2018) are all the studies that have established the importance of port infrastructure in international trade. Ports act as gateways for international trade and form a crucial part of the supply chain. For this reason, ports are natural focus areas for regional development. Each port services a far-reaching hinterland, which can span across

multiple countries. Improved port efficiency has a positive impact on trade flows (Wilson, et al., 2003).

Egypt, Morocco and South Africa have the most connected ports in Africa. Each one of these country's ports services a different geographical dimension of trade. Geographically, ports in West Africa are disadvantaged, as they are not located on North-South or East-West shipping routes. Port Louis in Mauritius, which falls under East Africa, is growing in terms of connectivity and offers transhipment services to other East and Southern African ports (UNCTAD, 2019). Mombasa and Dar es Salaam are still considered to be the major gateway ports for East Africa, but face high levels of congestion and extended dwell times. Botes et al.'s (2018) view on African ports and the development thereof has been summarised in the following two paragraphs.

'Hub' ports have started emerging as a global trend in port logistics and have proven successful in Hong Kong, Singapore and Dubai (Munim & Schramm, 2018). 'Hub' ports are container/break-bulk ports that facilitate major volumes of more than 2 million twenty-foot equivalent units (TEUs) per annum of global trade in and out of a region and can handle extremely large ships. Africa's development of 'hub' ports is lagging because total volumes and shipment sizes are smaller, resulting in higher unit costs for shipments: the cost to ship a single unit, for example a container can range from 1.5 to 3.5 times more from an African port than a higher volume port in a developed country, *ceteris paribus*. The maritime trade routes up and down East and West Africa have not adapted properly to feed from priority ports and are servicing the less dominant ports to the detriment of the large regional ports. African countries are spending money on their own smaller less viable feeder ports rather than looking at the bigger picture and investing as a region into the larger and more dominant ports, which can act as transhipment terminals.

Transhipment terminals allow goods to be offloaded from large ships and reloaded onto smaller ships that then transport the goods to smaller feeder ports that are off of the main shipping route. Feeder ports are limited both by the capacity of trade volume that they can manage and by the size of the ships that they can accommodate. The effective use of transhipment terminals, hub ports and feeder ports in combination can lead to much greater efficiencies in the maritime transport of the African region. African container ports in their majority are larger than a typical modern feeder port, which would attract a maximum of 100 000 TEUs in a year but are smaller in size than a true hub port. Most of the larger ports in Africa can to some degree fulfil the function of a hub port, but many of them are not large enough to properly leverage off economies of scale to the extent that is required for a hub-and-spoke system of transhipment to be cost effective. Low port efficiency and the fact that global shipping routes based on a hub-and-spoke model, which are successfully used in other regions of the world, have not been replicated in Africa are significant contributing factors to the lagged development of 'hub' ports in Africa. A hub-and-spoke shipping model is one where connections are arranged as a wheel and freight traffic travels along the spokes connected to what would be the central hub.

Eventually three hub ports are expected to truly arise in Africa, based on network theory; the location of the port and its level of shipping liner connectivity; the quantum of trade going through the port; and the size of the hinterland that the port services. Botes et al. (2018) have identified Abidjan, Mombasa and Durban as the most likely ports to develop into 'hub' ports for each of the three regions: Western Africa, Eastern Africa and Southern Africa, respectively. Ports that are likely to compete with aforementioned in their various regions are Lagos-Apapa, Tema and Dar es Salaam. Factors such as operational performance and political stability may also play a role.

Typically, port expansion investment in Africa is reactionary and only occurs after the port has been operating under strain for a period of time.

Globally, competition amongst ports is driven by efficiencies and costs, but in Africa, countries tend to direct all their trade through their own ports to protect investment in their port infrastructure. What this means is, heedless of the economic consequences and to their own detriment, African countries are willing to pay higher costs to use their own ports rather than use the cheaper and more efficient alternatives when they are available – this reduces competitiveness in the global market for those countries' exports. Part of this behaviour stems from the historical view of governments that ports are revenue streams, rather than trade and growth facilitating infrastructure. It is more about how much money can be made from the port than the function of the port and this can be seen through the choices around management and ownership of the ports.

Port inefficiency is identified through long container dwell times, vessel traffic delays, slow documentation processing and measurements relating to container per crane hours (Kahyarara & Simon, 2018). The competency of port management can impact ship dwell time. Cash constraints and low storage tariffs can exacerbate this problem. Raballand et al. (2012) explain that dwell time can be used for revenue generation and as a commercial instrument. Dwell time in African ports is typically over two weeks, whereas some of the world's larger ports consistently report dwell times of under one week. Longer dwell times increase terminal container congestion and in the presence of cash constraints can lead to collusion and other rent seeking behaviour, which further exacerbates inefficiencies. On average Port Louis, in Mauritius has been found to take 16 days to process cargo which means that its maritime trade infrastructure efficiency is equal to that of the United Kingdom (Djankov, et al., 2010). Variance in quality of seaport infrastructure across the continent is substantial.

Ports need to be well-managed and efficient in order to attract international shipping lines; the efficiency of the ports that shipping lines choose to service impacts their own competitiveness as a firm and their ability to ship goods reliably and on time for their customers. Local ownership of fleets is relatively low in Africa. Consolidation is taking place in the container shipping industry, which is evidenced by the market share of the top 10 shipping lines having grown from 68% in 2014 to a massive 90% in 2019 (UNCTAD, 2019). Liberia is the second largest ship registry in the world - it is only smaller than Panama – and makes up 12% of the world's ocean fleet. This can be deceptive as none of the ships registered in Liberia are actually owned locally. The case is the same across the rest of Africa, as local ownership of fleets is practically non-existent (Export-Import Bank of India, 2018). The consequence of a mismanaged port is the creation of a costly bottleneck, which disincentivises future trade and reduces competitiveness in the global market.

Across the continent, private operators are not popular, despite the fact that they have a stronger incentive to run a highly efficient port. However, this is beginning to change in West Africa, where there are eight or more private port operators compared to East and Southern Africa that cumulatively have four independent operators between them. 'Bolloré Ports' is an example of a private port operator in Africa. The company focuses on emerging markets and manages a number of African ports including Lomé in Togo (Bolloré Transport & Logistics, 2016). Lomé is one of the most modern ports on the continent, with significant investment having already been made into digitising processes such as computerised container scanning. Increased shipping line

connectivity for ports is possible through the investment and implementation of digital solutions that automate processes and eliminate paperwork. The Internet of Things and block chain are examples of digital tools than be used to improve port operational efficiency (UNCTAD, 2019). Shipping lines such as Maersk and MSC own some of the independent port operators; global shipping lines are strong determinants for port investment and the conversion of ports into inter-modal nodes. These joint ventures, whereby terminal operators and liner companies have engaged in the joint management of berths has deepened the vertical integration of the industry (UNCTAD, 2019).

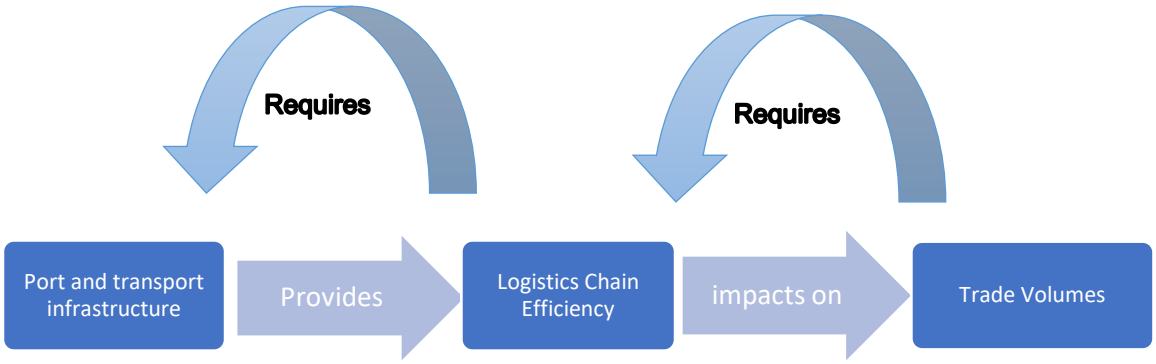


Figure 3-5 The Link between Transport Infrastructure and Trade Volumes

Source: Adapted from Botes et al. (2018)

Port performance can be measured based on infrastructure, landside transport connections, vessel connectivity, operations performance (efficiency of handling containers), and import/export processing efficiency (government instituted customs processes) (Botes et al., 2018). Port infrastructure comprises of physical design, available equipment and very importantly the container stacking capacity. Vessel connectivity refers to the access of the port to main shipping lines and the size of the vessels that stop at the port. The above-mentioned aspects of a port are the key areas where bottlenecks can arise – each area is reliant on another area. Maritime transport costs are on average equal to 6% of the import value of a good (Moïsé & Le Bris, 2013). Middle income countries benefit the most from improved port infrastructure and low-income countries benefit less (Moïsé & Le Bris, 2013). Low income countries are generally hindered by political instability and other business concerns which offset the benefit of improved port infrastructure. Key to increasing port efficiency is port management; investing to create larger capacity through port expansion to keep in line with trade growth; as well as reducing administrative delays where possible.

Purpose built bulk terminals that have the capacity for high volumes of throughput of commodities will be a crucial focus area for policy makers. Buchanan, Saldanha, and Port Saco are all examples of purpose-built bulk terminals. Port inefficiency is a binding constraint on the growth of maritime transport in Africa, but so is the lack of efficient rail and road networks connected to the ports. Large scale bulk terminals operate best when linked to dedicated rail networks. The improvement of intermodal facilities, back-end port logistics and deepened integration to railway networks is taking place in Africa but is still below the global standard. The connection between

ports and other transport infrastructure/ trade facilitation services to trade and the associated economic benefits of trade is going to be important in future policy shaping for regional integration and trade.

3.3.3.2. Overland: Railroad and Road Network

In Africa, ocean navigable rivers simply do not exist in an abundance. This eliminates the cheapest transport to the hinterland interior of the continent (Storeygard, 2016), which leaves the options of road, rail and air transport for landlocked countries. Overland transport is more expensive than maritime transport, but cheaper than transport by air.

Africa's total railway network is 82 000 km long, but only 84% of it is operational. These railways are not the highspeed trains of Japan and Italy, but are rather small scale and low speed networks with low axle loads. In 2016, 133 billion tonne-kilometres of freight was transported by rail in Africa, 85% of this was in South Africa. South Africa has the highest rail density in Africa and is one of only a few modern rail networks in Africa (Export-Import Bank of India, 2018). Egypt is another major user of rail on the continent, although the focus in Egypt is largely on passenger transport rather than freight carrying trains. The high number of landlocked countries and small economies that form part of the structure of Africa, make the region prime for the development of an efficient high capacity rail network. The majority of Africa's' existing railway networks, excluding South Africa and Egypt, are run-down relics from the colonial era that were constructed by mining companies during the resource boom (Export-Import Bank of India, 2018). The Africa Union of Railways and the African Branch of the International Union of Railways are the two main bodies responsible for the co-ordination of rail policies in Africa. Railroad transport differs vastly across Africa, but most of the railway lines connect inland areas to coastal areas. The highest railroad density in Africa, excluding Egypt and South Africa, is in the countries between Kenya and Mozambique and South Africa. A large proportion of the existing railroad is single track and not electrified. From a more technical point of view there are three different rail gauges in Africa: Cape gauge, narrow gauge and standard gauge – in general they do not cross over from one country to another (African Development Bank, 2015). Essentially what this means is that it is a common occurrence in Africa for neighbouring countries to have incompatible railways – if a train transported goods to the border, the goods would then have to be offloaded and loaded onto a different train on the other side of the border, as trains are designed to only work on one type of track gauge. In order for railways to be used more extensively for trade between African countries, there would need to be investment into the standardisation of railway tracks.

There are not many international railways in West Africa, but an example of one is Abidjan, Côte d'Ivoire to Ouagadougou, Burkina Faso. East and Southern Africa have a few more but integration is still lacking. The major railway ports of East Africa can be found in Dar es Salaam, Djibouti, and Mombasa. The East African Community devised an East Africa Railways Master Plan in 2009. The plan proposes reviving existing railways that extend through Tanzania, Kenya and Uganda and then extending railway lines into Rwanda and Burundi, before tackling South Sudan, Ethiopia and other countries. Maputo in Mozambique is a major railway port for Southern Africa. General neglect, civil wars and lack of funds are all reasons for Africa's poor railway network coverage and capacity. Growing urbanization, industrialization and a movement towards regional integrations are all reasons why further railway development in Africa would make sense.

Rail is better than road for the transport of high volumes over long distances. Generally, the longer the distance, the less suitable road is for transport. Railways do not make economic sense for low volume movement of goods. According to the African Development Bank (2015), railways are typically clustered and developed in areas that: either have large mines which need to transport their output to a port for shipment; or around intermodal corridors and large ports, linking various nodes; or in major metropolitan areas for the transport of people rather than goods. Africa is rich in natural resources and railways tend to be the most efficient mode of overland transport for bulk commodities. Road and railway networks are of critical importance to trade for landlocked countries. As much as seaports are considered to be the 'gateway' for trade, they don't matter very much without the connection that rail and road can provide to the hinterland. Domestic cabotage restrictions inhibit international shipping liners from extending their services to reach hinterland areas overland (UNCTAD, 2019). Removal of cabotage barriers would lead to increased shipping connectivity and allow expansion of transport services into Africa.

As Africa's road system has continued to grow and larger vehicles have become available for transporting goods so trade has been drawn away from rail transport to road transport (Bullock, 2009). Road transport is the mode most used for agricultural and food goods and according to Dorosh et al. (2012) there is plenty of evidence that investments in roads and greater road connectivity positively impacts agricultural productivity and output. Road transport infrastructure is complementary to other modes of transport, especially railway, as road is often required to complete the journey (African Development Bank, 2015), but occasionally road and rail compete directly with each other. Africa has a road network of 2.8 million kilometres, 72% of which is unpaved (Export-Import Bank of India, 2018) and less than 50% of the rural population lives in close proximity to an all-season road (The World Bank, 2008). Intra-continental trade is inexorably linked to road infrastructure. Spill over effects naturally occur from road transport as trucks travel through various countries between their departure and destination sites. Transit countries add to the trade flow as some goods may be offloaded along the way and new goods loaded on, not a possibility had air transportation been the mode of choice. Poor road conditions reduce truck life and increase maintenance costs. Extended transit time reduces the rate at which trucks can transport goods to ports – the further the distance the less efficient transport by road is. Improvements in the main road network that links the 83 major cities in Africa could potentially drive overland trade up by USD 250 billion over a period of 15 years (Buys et al., 2006). It would cost an estimated USD 35 billion to upgrade and maintain the road network.

Countries' road networks can change extensively and intensively. Extensive change refers to the expansion of the road network through the building of new roads. Most building will take place around existing roads, as it is cheaper than clearing and grading new land (Storeygard, 2016). In terms of intensive development, existing road surfaces can be upgraded and paved or widened. The length of total roads and the density are not necessarily indicators of the quality of a country's road network (Beuran, et al., 2015). Quality encompasses how well maintained the roads are, how well planned and organised the roads are. A well-planned road network will have been logically constructed to allow the most direct movement of goods and people from one place to another. At the same time a good quality road networks needs to connect rural areas to urban centres. Better road conditions lead to reduced fuel costs for logistics companies, which in turn encourages more trade to take place. Expansion should not always be the goal when reviewing a country's road network and Beuran et al. (2015) suggests that sometimes investment will be better spent on upgrading and maintaining the existing roads. However, Wessel (2019) argues that road density is more important for overland trade than the quality of the roads. Raballand et,

al. (2010) provide a decision tree for planning investment strategies for road projects that shows that there is correct time and place for both Beuran et al. (2015) and Wessel's (2019) arguments for what to spend money on when it comes to road infrastructure.

The trans-African highway network consists of transcontinental road projects that are being co-ordinated by the African Union, the African Development Bank, the United Nations Commission for Africa and the relevant regional economic communities. The nine highways forming the network have a total length of 56 683 km (African Development Bank, 2019). These highways span the length and breadth of the African continent linking some of the most important inland markets to seaports (Figure 3-6).

Figure 3-6 The Trans-African Highway Network

Source: African Development Bank (2019)

South Africa and Nigeria are the two largest economies in Africa but overland trade between the two countries is extremely low (Buys et al., 2006). One would expect trade to be high based on simple economic trade theory, but maybe this isn't surprising at all. The reason for the low quantum of trade is that the road distance between the two countries is vast and the costs will be too high for trade between the countries to be of benefit using this mode of transport. The largest variable cost involved in road transport is fuel costs (Beuran et al., 2015). It is also important to

note the quality of the roads in the transit countries. Wessel (2019) asserts that the infrastructure quality of transit countries is a significant driver and inhibitor of overland trade flows for both rail and road transport modes. Although South Africa has high quality roads, the low quality of the roads in transit countries between Nigeria and South Africa is largely inhibiting (Table 3-1). Road conditions deteriorate significantly in the middle of the journey – a score of 100 is considered the best possible score. Even if the roads were in perfect condition, transport by road would still not be the most efficient and cost-effective choice for the exporter. Looking beyond the physical cost of the transportation mode, overland travel has its own set of complexities that maritime does not. Moving goods from South Africa to Nigeria or vice versa would require the goods to cross a minimum of 8 borders. This adds significant administration and customs burdens for the exporting firm. The distance column indicates the shortest distance by road through each country to get to the next country. The distances shown in Table 3-1 highlight that although road quality is good in South Africa (in this example the exporting country), a significant portion of the journey (85% of total distance) is through transit countries, most of which have very low road quality.

Table 3-1 Overland Trip from South Africa to Nigeria (Shortest Route by Distance)

Country	Distance (km)	Road Quality
South Africa	313.6	100.0
Botswana	842.0	87.5
Namibia	1056.2	25.9
Angola	1875.8	15.8
Democratic Republic of Congo	582.3	3.8
The Republic of Congo	389.7	13.6
Gabon	820.0	19.2
Cameroon	829.8	18.4
Nigeria	805.3	32.3
Total	7514.7	30.1

Source: Buys et al. (2006)

The largest constraint for most African countries, when it comes to increasing their exports and expanding their reach to alternative markets, is overland transport of goods in the hinterland (Freund & Rocha, 2010). Improving inland transit in Africa is not going be a cheap, quick or simple process, but there will be ancillary benefits such as increased movement of factors of production between countries that will stimulate further intra-regional trade in the long term (Akpan, 2014).

3.3.3.3. Air Freight

Air transport is faster than any other mode of transport, but is also the most expensive (Hummels & Schaur, 2013). Air freight is the optimal mode of transport, when timely delivery is crucial and the goods being transported are valuable enough to outweigh the high cost premium (Harrigan, 2010). Air transport as a mode of transport is continuing to carry a rising share of world trade. The price elasticity of the demand for a good, and consumers' demand for fast delivery determine whether a good is shipped by sea or by air. Goods transported by air are typically higher in value than those transported by sea. Hummels and Schaur (2013) estimate that an additional day of transit is worth up to 2.1% in the value of the good being transported,

About two thirds of African air cargo is shipped to Europe. African air exports are typically counter-seasonal agricultural products of high value such as cut flowers and other perishables, but there is relatively little return cargo from Europe (The World Bank, 2009). Examples include Uganda which exports vegetables by air to Europe, and South Africa which exports citrus and other fruit to the European markets. One of the principal factors limiting the volume of airfreight in developing countries is the lack of significant volumes of bi-directional trade. To facilitate air freight, landlocked countries need to improve operations at their airports and liberalise access for foreign airlines.

The short transport time that airfreight can deliver, allows the shelf life of certain goods to be extended, especially fresh fruit and vegetables. It allows for short notice delivery allowing importers to operate on just in time models, reducing inventory expenses for products that are difficult to store. Another example is fruit which can be left on the tree to ripen for longer due to the fact that transit time is guaranteed to be short. Unit costs for air travel increase for shorter distance due to the fact that a larger proportion of the trip time is spent on the ground and time in the air is largely ascending and descending which consumes more fuel (The World Bank, 2009). Road transport is therefore preferable for domestic transport of goods.

There is little mention in literature about any intra-African trade of agricultural goods by air. One likely reason is that the cost of air transport in Africa is too high to justify intra-African exports. Air transport costs are driven up when there are low volumes of trade and the required infrastructure is underdeveloped. The point made about little return cargo from Europe is an important one, as air carriers have to charge accordingly to ensure they are compensated for empty hold flights back to Africa. This has been exacerbated by COVID-19, as the suspension of international passenger flights has reduced the cargo capacity for transporting agricultural goods between African countries and Europe by about 75% (Pais et al., 2020).The dramatic reduction in capacity has pushed cargo costs to double for Kenya's horticultural sector, which in turn has made it difficult for producers to fulfil orders.

Internationally, airlines have slowed their expansion of cargo capacity. In annual terms, air freight tonne kilometres are up 1.5% from 2018 to 2019, whereas during the course of 2018 there was an average monthly growth of 5% (IATA, 2019). African air freight has, however been expanding in 2019, whilst all other regions have been retracting and have been doing so consecutively for the 10-month period before August 2019 (IATA, 2019). Part of the reason for this ongoing exception is that African air freight is growing off a small base of less than 2% share in the total world market of air freight. Growth in African air freight has been supported by improved trade lines with Asia, resulting from large investment in key Asia-Pacific countries including China. International air freight tonne kilometres growth for July and August 2019 can be seen in Figure 3-7. Although growing, intra-African air transport growth is hampered by underdeveloped airport infrastructure, limited connectivity, poor transit facilities and a shortage of human capital (Export-Import Bank of India, 2018).

In 2018, the African Union launched a Single African Air Transport Market initiative to improve intra-African air connectivity (IATA, 2018). 23 countries have signed up to the initiative but for the benefits to be realised, 12 of the countries will need to open their markets. IATA (2018) predicts that if this happens, it will bring an additional USD 1.3 billion of GDP to each of those economies annually. Augmented air connectivity should drive demand and increase competitiveness amongst African airlines. It must be noted that it is not clear whether the Single African Air

Transport Market initiative is focused on passenger transport or freight or a combination of both, but increased focus on the air industry should bring investment with spill over effects, as both passenger planes and cargo planes make use of the same airport infrastructure. Air infrastructure has been found to have a more substantial impact on airborne trade than what maritime infrastructure has on seaborne trade (Korinek & Sourdin, 2011). In general, the higher a country's GDP per capita, the larger the marginal benefit of improving airport infrastructure, with the exception of low income, landlocked countries, which can benefit highly from investments in airport infrastructure. Improved airport infrastructure in these countries unlocks an opportunity for direct trade and reduces reliance on neighbours.

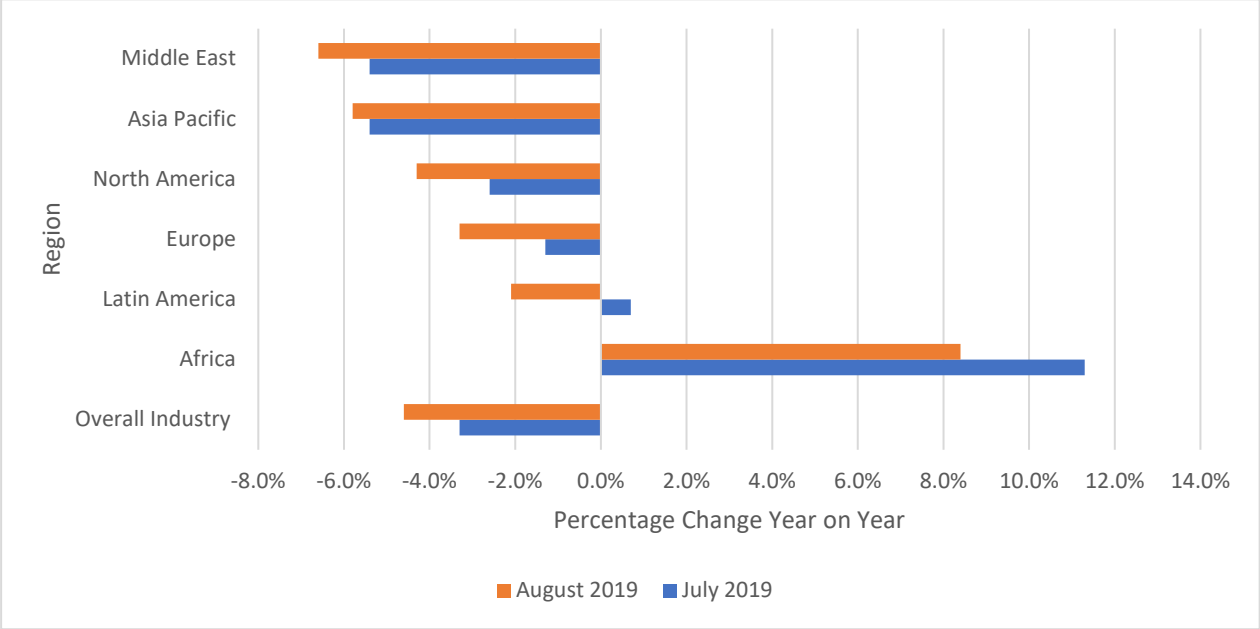


Figure 3-7 Percentage Year on year Growth in International Freight Tonne Kilometres by Region

Source: Adapted from The International Air Transport Association (2019)

3.3.4. Customs Environment

Trade facilitation also includes the regulatory environment of trade, e-business usage and the customs environment. The customs environment encompasses the process of moving goods through customs and the border. Long and unpredictable customs delays for processing exports, as a result of incompetence or corruption is a common occurrence in Africa. The customs environment was covered in the latter part of Chapter 2.

Customs agencies are responsible for collecting taxes and revenue, ensuring that illicit goods do not cross the border and preventing fraud. The customs environment forms part of the overall logistics quality of a country. Delays in customs clearance negatively impact a firm's ability to export, particularly when goods are destined for new clients. Improvement of customs processes can be achieved through the implementation of risk-based verification procedures, which increase efficiency by reducing the number of shipments that are checked (Martincus et al., 2015). It is key to note that this does not mean relaxing monitoring or reducing the quality of checks but rather increasing the education of officials through training so as to make smart decisions and streamline their tasks.

The Doing Business 2020 report shows that African countries on average take the longest out of all the regions to complete both export and import border and documentary compliance (Figure 3-8). The one exception is with export documentary compliance, where South Asia takes the longest according to the report. Typically, it takes longer to complete import compliance activities than what it does to complete export compliance activities. In terms of costs to complete export and import border and documentary compliance, Africa once again features at the top. In general, the financial costs of border compliance are higher than those for documentary compliance (Figure 3-9*)*.

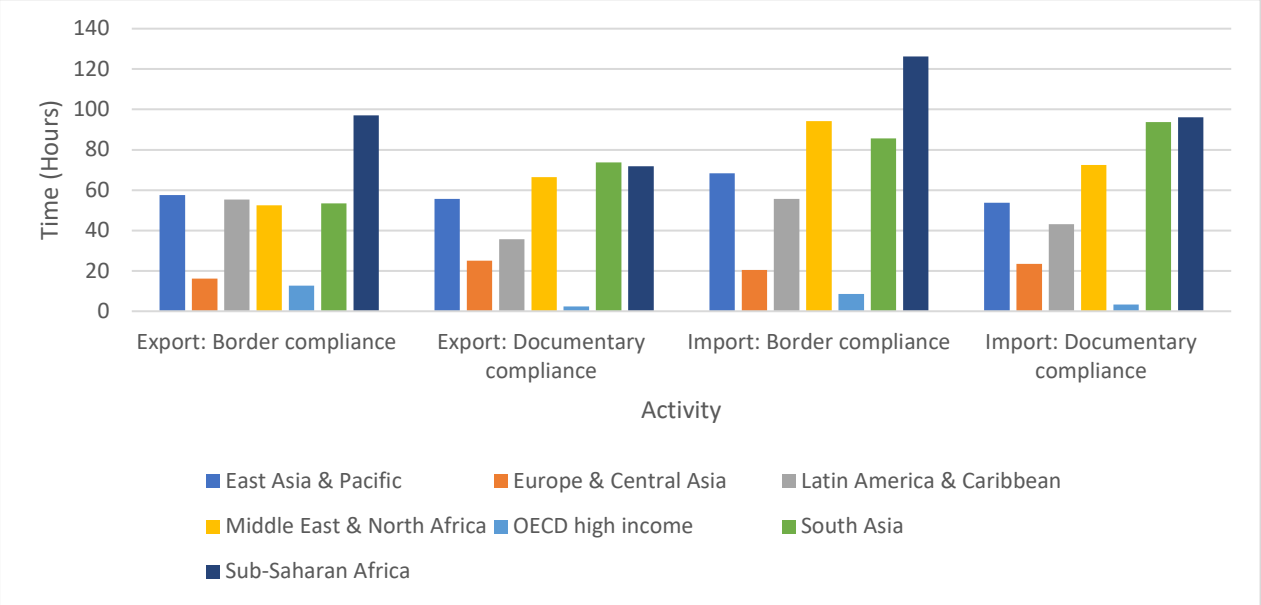


Figure 3-8 The Time Taken to Complete Border and Documentary Compliance in Different Regions in 2020

Source: The World Bank (2020)

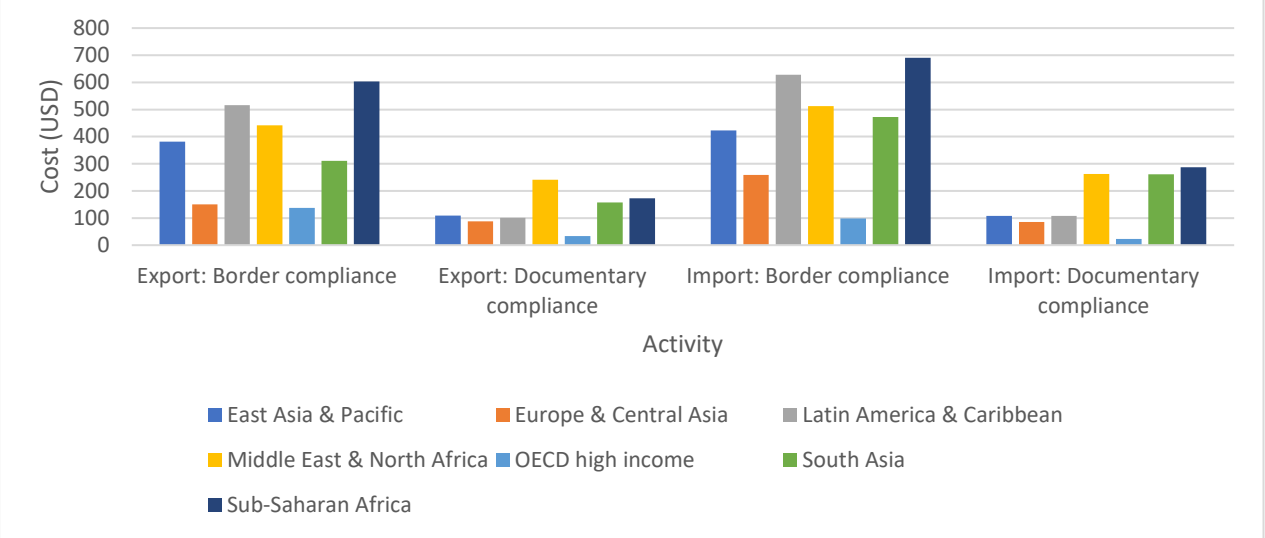


Figure 3-9 The Costs for Border and Documentary Compliance in Different Regions in 2020

Source: The World Bank (2020)

Customs and trade regulations are a serious constraint for African enterprises. The speed at which African countries clear exports and imports is much slower than other regions; on average African imports take 30% longer to clear customs than the global average (Stuart, 2020).

It is costly and slow to clear goods at customs and border posts in Africa. The average customs transaction requires 20-30 different parties, 40 documents, and 200 data elements of which many need to be repeated (Parka, 2012). Two complete sets of controls need to be dealt with in the majority of African countries when goods cross borders; there is normally one control on each side of the border post. At each control documents need to be completed and approved. It has been estimated that a single day of delay at customs is the same as adding 85km of distance between the countries in terms of cost escalation. Automated systems for document checking and clearing is a possible solution for decreasing time delays at border posts, but this type of technology is not frequently encountered across the continent. Access to power and the ability to repair the machines are also issues that would need to be addressed following adoption in order for the benefit to be retained in the medium to long term. In-efficient border posts are a hindrance to intra-African trade as it makes it unappealing to transport goods through transit countries and/or through countries to reach a port. Lack of transparency regarding the calculation of duties and taxes is also often called into question and creates problems for trade.

It is commonly believed that most transport delays occur en route or at border posts in the hinterland, but according to Beuran et al. (2015) this is contrary to the truth of the matter. Road and border delays are normally more marginal than those experienced in ports, when there are bottlenecks. However, Beuran et al. (2015) does acknowledge that border crossing time is of particular importance in Southern Africa. A one stop border post is a potential solution to reducing border crossing times in Africa. The concept is that the removal of one border control check at every border, which will halve the border crossing time. In reality customs clearance of exports is normally not completed at the border itself so this proposed solution will not always have the desired impact. Export controls are responsible for roughly a third of the total border crossing time, whereas import controls often account for half of the time or more (Beuran et al., 2015), thus the simplification of import controls should be seen as a more urgent matter.

3.3.5. Investment

The ability of the AfCFTA to succeed in its goals may to some degree be dependent on the capacity of investors to provide sufficient funding to develop infrastructure in key projects across the continent (The Infrastructure Consortium for Africa, 2017). Investment in both hard and soft infrastructure has been empirically proven to increase trade flows, while theoretical studies indicate that developing countries should prioritise investment into their domestic infrastructure over international infrastructure (Olarreaga, 2016).

Beuran et al. (2015) explains that road investments in Africa are based on two key hypothetical assumptions. The first assumption is that investing in road infrastructure always increases traffic and alleviates poverty. The second assumption is that under any conditions a well maintained and good quality road will have large economic benefit. The problem with these assumptions is that they create an expectation that whenever roads are invested in, there will be resounding benefits. In reality sometimes the costs are too high and the project is not sustainable, but these facts are overlooked by investors in an eagerness to expand road networks. The economic evaluation of any infrastructure or trade logistics project is important in weighing up the costs

against the potential benefits. This is to ascertain whether the available funds are going to be used in the most beneficial way possible and on projects that will have the greatest impact. Changes in transport costs and the attraction of a region for trade partners due to the project can have an effect on trade competitiveness both in regional and international markets, which is a key consideration

The planning of port infrastructure projects requires careful identification of a port that will be most attractive to importers and exporters and therefore will benefit most from investment that will increase either capacity and/or efficiency (Vega et al., 2019). Considerations include the cost to access the port, the frequency of maritime lines, maritime freight rates, maritime travel time, the origin and/or destination, cargo type are all things that influence importers and exporters choice of port to use (Vega et al., 2019).

The Infrastructure Consortium for Africa's 2017 report on the infrastructure financing trends in Africa provides a comprehensive overview of existing investments into African infrastructure. According to the report, investment commitments totalled $81.6bn in 2017, of which 41.7% was designated for transport infrastructure. Chinese investment into infrastructure on the African continent is substantial, totalling $19.4bn in 2017, which was 23.8% of total investment that year (The Infrastructure Consortium for Africa, 2017). Transport infrastructure is predominantly financed by National African Governments, ICA members and China (Figure 3-10). $3.4bn of the $34bn invested in transport infrastructure was from China but the vast majority can be attributed to African national governments' investments. Specific projects invested into by China, include the Mombasa-Nairobi railway in Kenya, and the construction of a railway linking Addis Ababa in Ethiopia with Djibouti's coastal capital.

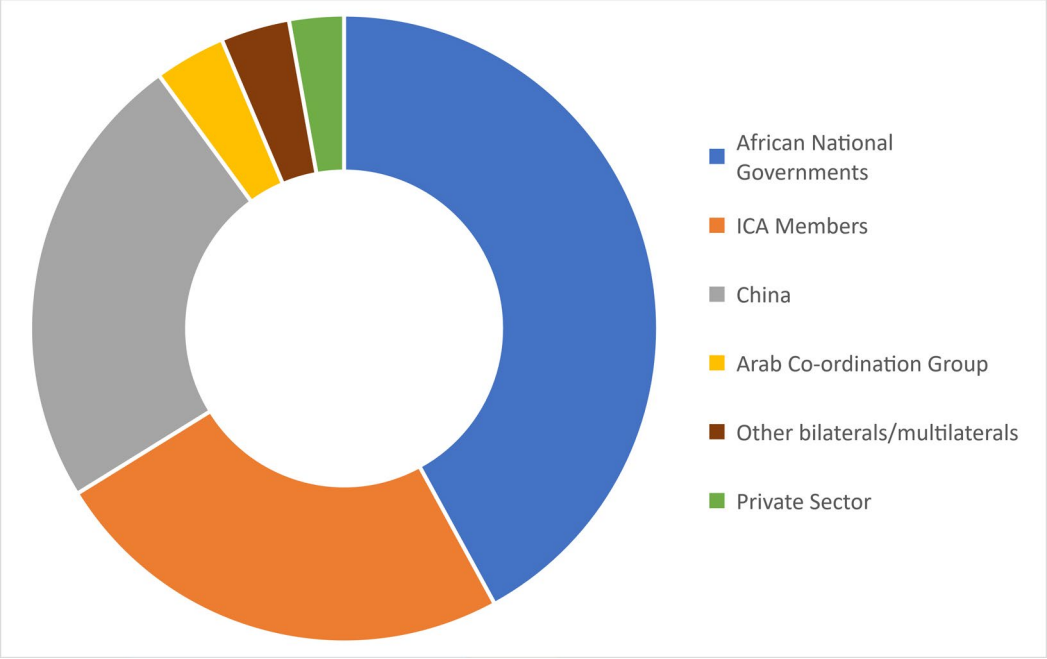


Figure 3-10 Sources of Investment for African Infrastructure in 2017

Source: The Infrastructure Consortium for Africa (2017

The World Bank, the G-20, and the African Development Bank, amongst other institutions all have estimates of what they regard to be the annual required infrastructure investment requirement for Africa. The estimates vary from USD 93 billion to USD 174 billion (Export-Import Bank of India, 2018) but the ICA 2017 report goes further to suggest that the gap specific to transport infrastructure falls within the range of $3bn to $15bn annually. Closing this investment gap is possible with greater public private sector contributions in conjunction with political commitment to regional projects.

China has already established itself as a major investor in African infrastructure projects through its 'Belt and Road' initiative. The 'Belt and Road' initiative is a multi-billion-dollar strategy to improve access between Asia, Europe and Africa. Key to this initiative is developing infrastructure in African countries by providing considerable finance. The Standard Gauge Railway between Mombasa–Nairobi was financed and completed in 2017 as part of the "Belt and Road Initiative (Hanaoka et al., 2019).

The leading global transport, freight and logistics firms have a growing interest and are expected to increase their investment into Africa, as there is the potential for high returns, especially in countries that have previously been underserviced from a logistics perspective. The inclusion of multi-nationals and global players will push African transport infrastructure to integrate with multi-model terminals that will strengthen the logistics supply chains. As mentioned earlier in this chapter, investments in African ports have up until now been mostly reactionary and driven by supply side factors. This will likely change as demand side factors apply increasing pressure, by 2040 port demand volume is predicted to have grown by 6-8 times. This presents a challenge in Africa as inadequate ports may result in losses of over 2% GDP per annum (Botes et al., 2018). The question going forward for Africa is whether investment will pre-empt the demand or will it be a reactionary investment only once ports are under strain and income is being lost out on. Ideally African governments and regional economic communities should be pre-emptively investing in dominant ports that have been identified as future hub ports; investment in these ports to improve their efficiency will make them attractive to international shipping lines and accelerate changes to shipping routes allowing for greater regional efficiency in trade. If shipping lines start re-allocating larger vessels to African ports, it will reduce transit time and the cost of trading in Africa (Botes et al., 2018).

3.4. Measures of Trade Logistics Quality

There is more than one measure of trade logistics quality available in the public domain. This sub-section discusses three such measures and provides reasoning as to which one is deemed the most suitable to be used in this study's gravity model.

3.4.1. Global Competitiveness Index

The World Economic Forum produces an annual Global Competitiveness Report which ranks and scores countries on various criteria. The 2019 report features the Global Competitiveness Index (GCI) 4.0, which evaluates the national competitiveness of 140 economies and provides insight into the drivers of economic growth. Productivity levels of a country are intrinsically linked to its national competitiveness, and openness in trade adds to competitiveness. The index is compiled

through a “distance to frontier” approach meaning that each component of each country is compared to a bench mark (Schwab, 2018).

There are 12 pillars that form the index:

1. Institutions
2. Infrastructure
3. ICT Adoption
4. Macroeconomic Stability
5. Health
6. Skills
7. Product Market
8. Labour Market
9. Financial System
10. Market Size
11. Business Dynamism
12. Innovation Capability

Pillars 1-4 make up the “enabling environment”, 5-6 “human capital”, 7-10 “markets”, and 11-12 “the innovation ecosystem”. The pillars can also be referred to as the drivers of productivity. The report splits Africa in “Sub-Saharan Africa” and “Middle East and North Africa”. As Sub-Saharan Africa encompasses the majority of African countries, 48 out of 56, this is the region in the report that is of most interest. Sub-Saharan Africa has the lowest score for all pillars (Table 3-2), except the Product Market and Labour Market pillars, where Sub-Saharan Africa has marginally better scores than South Asia (Schwab, 2018).

Table 3-2 Regional Performance by Pillar (Average Score 0-100)

	Institutions	Infrastructure	ICT Adoption	Macroeconomic	Health	Skills	Product Market	Labour Market	Financial System	Market Size	Business Dynamism	Innovation Capability
East Asia and the Pacific	62	75	70	90	84	67	62	67	74	68	66	54
Eurasia	54	68	60	75	71	66	56	64	52	50	62	36
Europe and North America	65	80	70	93	89	75	60	66	71	60	68	58
Latin America and the Caribbean	47	61	51	74	82	59	52	56	60	51	54	34
Middle East and North Africa	56	71	58	75	81	63	57	55	64	60	58	41
South Asia	50	59	35	75	68	50	46	52	60	68	58	36
Sub-Saharan Africa	47	45	34	69	51	44	49	55	51	40	52	29

Source: Schwab (2019)

The higher a country or region's score the better its rating in terms of competitiveness for that pillar (Table 3-2). The regional leaders in Sub-Saharan Africa for 2019 are Mauritius with an overall score of 64.3 and South Africa with an overall score of 62.4. Their scores are almost double that of the least competitive countries in Sub-Saharan Africa. A few countries have established themselves as regional leaders of specific pillars; Kenya is becoming an innovation hub and Rwanda has the highest quality institutions. Pillar 2: Infrastructure, is the pillar most relevant to logistics quality; this pillar captures information on "the quality and extension of transport infrastructure (road, rail, water and air) and utility infrastructure" (Schwab, 2018). There is an inference that 'better-connected' geographic areas are more prosperous than those areas that are 'poorly-connected'.

3.4.2. The World Bank's Ease of Doing Business: Trading across borders

Annually the World Bank produces a report with 'Ease of Doing Business' scores for each country. The distance from frontier method is used, and each country's score is calculated by combining measures of different units such as the amount of 'time to start a company' or the 'procedures to transfer a property, which are representative of how easy it is to do business in a given country (The World Bank, 2019).

The Ease of Doing Business report has a specific section that looks at the ease of cross border trade. This report, like the Global Competitiveness Index, also differentiates between Sub-Saharan Africa and North Africa. Sub-Saharan Africa is one of the two worst regions for every single measure of cost category, both monetary and time for cross border trade – this indicates that Sub-Saharan Africa is a very expensive region to trade with (The World Bank, 2019). In 2020, Sub-Saharan Africa scores the lowest out of the regions and the Middle East and North Africa score the second lowest for the ease and cost with which trade across borders can be achieved (Figure 3-11).

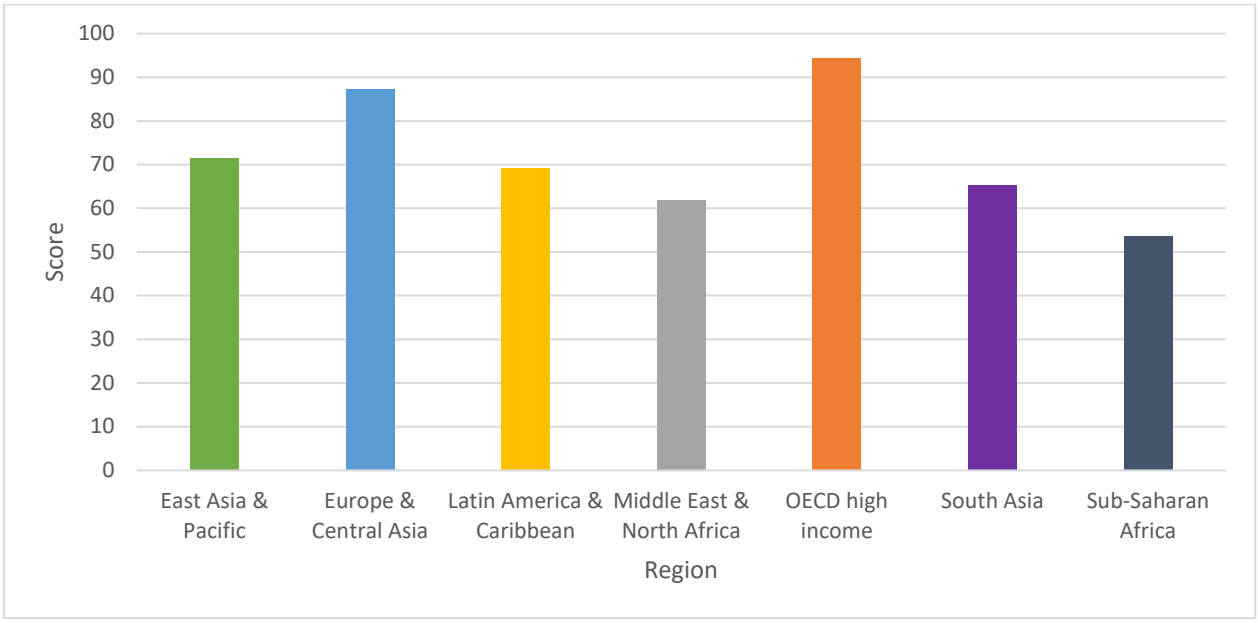


Figure 3-11 Regional Trading across Borders Score for 2020

Source: The World Bank (2020)

3.4.3. Logistics Performance Index

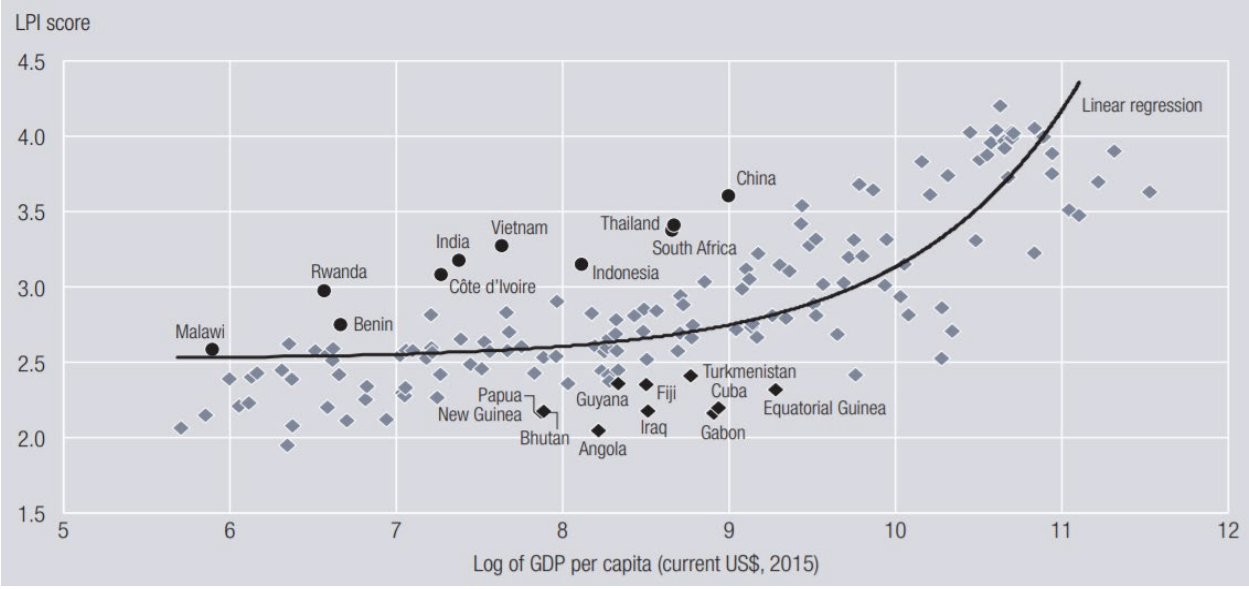
The World Bank's international Logistics Performance Index (LPI) is a biennially produced global benchmark for over 160 countries and is comprised of 6 indicators:

1. The efficiency of customs and border management clearance
2. The quality of trade and transport related infrastructure
3. The ease of arranging competitively priced international shipments
4. The competence and quality of logistics services
5. The ability to track and trace consignments
6. The frequency with which shipments reach consignees within the scheduled delivery time

The LPI data is gathered from surveys completed by logistics practitioners and the final international LPI score of 1 to 5 that is given to a country is the weighted average of the six indicators. Sub-Saharan Africa as a region has the poorest LPI scores across all dimensions except for international shipments, where Sub-Saharan Africa has a marginally better score than South Asia (Arvis et al., 2018).

Countries can be categorised based on their score as: logistics unfriendly, partial performers, consistent performers or logistics friendly. There is a gap between low income and high-income countries' LPI scores but income is not the only factor that influences a country's LPI, which is evidenced by the fact that LPI scores can vary vastly amongst income group peers (Arvis et al., 2018). Countries can be classed as overperformers or underperformers depending on whether they surpass or lag behind their income group peers. In Figure 3-12 non-high-income overperformers are indicated by the black circles and non-high-income underperformers are indicated by the black diamonds. From an African perspective, one can see that Malawi, Rwanda, Benin, Ivory Coast and South Africa are relative overperformers and Angola, Gabon and Equatorial Guinea are relative underperformers when it comes to logistics performance.

Figure 3-12 Overperforming and Underperforming Countries



Source: Arvis et al. (2018)

In 2018, the highest scoring African countries were South Africa, Ivory Coast, Rwanda, Egypt and Kenya (Table 3-3). Conversely, the lowest scoring African countries were Angola, Burundi, Niger, Sierra Leone and Eritrea. For comparative purposes, Germany which was the highest scoring country in the index, had a total score of 4.2 out of 5; the United States of America had a score of 3.89 and the top 7 ranked countries all scored above 4. Comparatively Sub-Saharan Africa as a region scored 2.45 and was the worst ranked region. The top scoring African country was South Africa with 3.38 – SA was ranked 33rd overall. Kenya which rounds out the top 5 for Africa is ranked 68th overall. Afghanistan had the lowest score overall of 1.95 and is ranked 160th out of the 160 countries that were measure in 2018.

Table 3-3 The Highest Scoring African Countries for Overall LPI in 2018

Top African Countries 2018	Score (1-5)
South Africa	3.38
Ivory Coast	3.08
Rwanda	2.97
Egypt	2.82
Kenya	2.81

Source: Arvis et al. (2018)

The top scoring African countries for the various components of the international LPI score are given in Table 3-4.

Table 3-4 Top Scoring African Countries for International LPI Components in 2018

Top 5 Scoring African Countries in 2018						
Overall International LPI	**Customs**	**Infrastructure**	**International Shipments**	**Logistics Quality & Competence**	**Tracking and Tracing**	**Timeliness**
South Africa	South Africa	South Africa	South Africa	Ivory Coast	South Africa	South Africa
Ivory Coast	Ivory Coast	Ivory Coast	Rwanda	South Africa	Ivory Coast	Benin
Rwanda	Sao Tome & Principe	Egypt	Ivory Coast	Mauritius	Mali	Rwanda
Egypt	Mauritius	Mauritius	Zambia	Rwanda	Kenya	Liberia
Kenya	Rwanda	Djibouti	Burkina Faso	Egypt	Mauritius	Tunisia

Source: Arvis et al. (2018)

South Africa dominates across all of the sub-categories and is only beaten the Ivory Coast in terms of 'Logistics Quality & Competence'. Sao Tome and Principe rates highly for their 'Customs" score but is not the top five for any of the other categories. This is the case for Djibouti, Zambia, Burkina Faso, Mali, Benin, Liberia and Tunisia, all of which break into the top five but only for a single category. On the other hand, Mauritius features in the top five for four out of six categories but doesn't make it into the top five based on overall LPI score.

The World Bank also produces a domestic LPI for 100 countries. The domestic LPI survey is completed by professionals that operate within that country. The four main determinants used in calculating the domestic LPI are infrastructure, services, border procedures and time, and supply chain reliability. The focus of the domestic LPI is inward looking and centred around domestic logistics processes.

3.5. Conclusion

This chapter focused on trade logistics because it is a central theme to the study. The chapter started by defining trade logistics as the range of services and process required to move goods from one country to another. Trade logistics is then broken down into two main components transport infrastructure and the overall customs environment. Higher logistics quality equates to firms being able to move goods across borders more reliably and efficiently. Efficiency in the context of trade means quicker and cheaper. Reliable export times, as a result of high-quality trade logistics components, allow both exporters and importers to better control their inventories and increase their internal operating efficiencies thus increasing their competitiveness in the global market. The main benefits of improving trade logistics were highlighted as market expansion, increased competitiveness, enhanced ability to leverage off economies of scale and increased specialisation.

The next section of the chapter addressed trade logistics in the context of Africa. A short background piece attempts to explain why Africa currently has inadequate infrastructure and inefficient logistics; it is predominantly due to the geography of the continent and the widespread occurrence of rent seeking activities. The three modes of transport and their corresponding infrastructure are then considered and discussed. The main take-aways from this section being that intermodal hubs and trade corridors are going to be crucial for the future of trade in Africa; and selective investment in regions will be important in determining future trade logistics quality and trade performance. To summarise the current situation, road conditions in Africa are extremely poor; rail networks are slowly growing; congestion is the number one problem with Africa's existing ports; and there appears to be substantial potential for growth in air freight.

When looking at investment, it was noted that it is not just about the quality of the transport infrastructure and overall trade logistics but also about the density and reach of the available transport networks. Trade corridors, which extend reach and increase market access will drive intra-regional trade especially for landlocked and smaller economies. This is where selective investments can have a significant impact.

As mentioned in the chapter, there are three widely used and acknowledged data bases that cover trade logistics quality; the Global Competitiveness Index, the Ease of Doing Business

Report and the Logistics Performance Index. The Logistics Performance Index is the easiest of the data sets to work with and is specifically geared towards measuring logistics performance, whereas with both of the other two measures, the scores would have to have to be disaggregated for use in a gravity model. For this reason, the LPI is the measurement of choice for logistics quality in this study.

To conclude, the literature shows that there is a reciprocal influence between trade volumes and trade logistics quality. Trade volumes can drive improved trade logistics by necessity, but pro-active investment in trade logistics can also stimulate trade. The next chapter will look at the theory of the gravity model, which is the method for determining the influence of various factors on bilateral trade between countries.

4. A Theoretical Discussion of Gravity Models

4.1. Introduction

The gravity model is a popular method for measuring the impact of different factors on trade volumes. Chapter 4 begins by giving a basic literature review of the gravity model. The review explains the history and the theory of the model, before going on to discuss the 'distance puzzle'. The various estimation methods for gravity models are then explored and the pros and cons of each method are outlined. The common challenges that are encountered with the use of gravity models are worked through and basic solutions from other papers are suggested. The Chapter concludes by providing a summary of relevant studies that have used gravity models.

4.2. Theory

In literature, the gravity model is commonly referred to as the workhorse of international trade analysis. It was first introduced by Tinbergen (1962), who linked the importance of distance, GDP and trade barriers to volumes of bilateral trade, but it was only in the early 2000's that the gravity model emerged as a mainstream modelling framework. The gravity model has become a tool, which researchers can use to test their theories on how various factors influence bilateral trade flow. These factors can be anything that potentially directly or indirectly impact the cost of trading, which includes but is not limited to transportation costs, tariffs and non-tariff barriers. The basic theory is that bilateral trade can be explained by a number of factors that either determine a country's potential to export or import goods and services or influence the magnitude of trade between countries (Marti et al., 2014). The gravity model is an ex-post analysis that can be applied under a variety of circumstances to a wide range of goods and other factors that move over regional and national borders, while generally providing a good fit (Anderson, 1979). It has become an extremely popular theoretical framework and has been used in hundreds of published papers. The main attributes that have resulted in its widespread success are its intuitiveness; its solid theoretical foundations; its ability to represent a realistic general equilibrium environment; its predictive power; and its high level of flexibility in application (Yotov et al., 2016). The modern gravity model is able to provide an empirical account of bilateral trade.

The traditional gravity model, also known as the intuitive gravity model was first developed by Tinbergen (1962). Tinbergen's (1962) initial specification, although a-theoretical has been widely used as it generally provides a good fit for most trade flow data (Helpman et al., 2008). The choice of variables for the traditional model are intuitively those which are expected to influence trade volume (Shepherd, 2013); GDP is used as a proxy for the demand and supply, while distance is used as a proxy for transport costs. Simply put, trade between two countries is determined by the product of their GDP and is inversely proportional to the distance between the two countries that are trading, which is analogous to Newton's law of universal gravitation.

The most basic version of the intuitive gravity model (Equation 4-1) closely resembles Newton's Law of gravity (Equation 4-2). Exports are directly proportional to the economic mass of the two trading countries and inversely proportional to the distance between these countries, whereas in

the physics equation the distance between objects is squared. The most basic version of the intuitive gravity model (Equation 4-1) can also be written in a log linear form (Equation 4-3).

Equation 4-1

$$X_{ij} = GS_iM_j\phi_{ij}$$

X_{ij} is the value of exports from i to j
G is a variable that doesn't depend on either country i or country j
S_i is all exporter specific factors that represents the total amount the exporter is willing to supply
M_j is all importer specific factors that make up the total importer's demand country j
ϕ_{ij} is the ease of exporter i to access the market of importer j, which is the inverse of bilateral trade costs

Source: Adapted from Bacchetta et al. (2012)

Equation 4-2

$$F_{ij} = G\frac{M_iM_j}{D_{ij}^2}$$

F_{ij} is the gravitational force between objects i and j
G is the gravitational constant
M_i is the mass of object i
M_j is the mass of object j
D_{ij} is the distance between object i and object j

Source: Head (2000) and Yotov et al. (2016)

Equation 4-3

$$lnX_{ij} = lnG + lnS_i + lnM_j + ln\phi_{ij}$$

X_{ij} is the value of exports from i to j
G is a variable that doesn't depend on either country i or country j
S_i is all exporter specific factors that represents the total amount the exporter is willing to supply
M_j is all importer specific factors that make up the total importer's demand country j
ϕ_{ij} is the ease of exporter i to access the market of importer j, which is the inverse of bilateral trade costs

Source: Bacchetta et al. (2012)

The stability and explanatory power of the intuitive gravity model prompted Anderson (1979) to look for a theoretical base to support the model. Anderson (1979) used the Armington assumption and trade costs modelled as iceberg costs to take the first steps towards showing that there is micro-economic theory supportive of the model. Other authors to generate evidence for the theoretical grounding of the model, include: Bergstrand (1985), Deardorff (1998), Eaton and Kortum (2002), Helpman et al. (2008) and Chaney (2008), but probably the biggest breakthrough came in the form of Anderson and van Wincoop's (2003) 'Gravity with Gravitas' paper, which dealt

with the concerns around the intuitive gravity model's lack of consideration for relative price effects (Bacchetta et al., 2012). Anderson and van Wincoop (2003) devised the concept of multi-lateral trade resistance terms to control for price effects and to ensure a better specified version of the gravity model. If there is a change in the trade cost on one particular bilateral trade route, this would then according to standard economic theory influence trade on other competing bilateral routes but this is not registered by the intuitive gravity model. Anderson and van Wincoop (2003) introduced two new terms to the gravity model: inward multi-lateral resistance and outward multi-lateral resistance. Outward multilateral resistance accounts for the fact that exports from country i to country j are dependent on all other export market's trade costs. Inward multi-lateral resistance is the same, except that it deals with the trade costs of all other import markets. These terms can handle the changes in trade cost on one bilateral route and how that affects trade flows on all other routes because of relative price effects.

Anderson and van Wincoop's (2003) structural 'gravity with gravitas' model is given in the commonly used log-linear form (Equation 4-4*)*. Shepherd (2016) illustrates the full derivation of the equation.

Equation 4-4

$$lnX_{ij}^{k} = lnY_{i}^{k} + lnE_{j}^{k} - lnY^{k} + (1 - \sigma_{k})[ln\tau_{ij}^{k} - ln\Pi_{i}^{k} - lnP_{j}^{k}]$$

X is exports indexed over countries (i and j) and sectors (k)
Y is GDP
E is expenditure (differs from GDP in terms of sectors)
Y^{k} is World GDP
σ_{k} is the intra-sectoral elasticity of substitution
τ_{ij}^{k} is trade costs
Π_{i}^{k} is the outward multi-lateral resistance term
P_{j}^{k} is the inward multi-lateral resistance term

Source: Shepherd (2016)

Gradually over time the Tinbergen's (1962) approach has been augmented and adapted with theoretical underpinnings to the extent that the theoretical gravity model, also known as the structural gravity model, is separately recognized from its predecessor, the intuitive gravity model. The main differentiation between the two models, is that although the traditional gravity model has empirical success it lacks a theoretical foundation, whereas the structural gravity model has solid micro-economic foundations. Thus far, Anderson and van Wincoop (2003) have provided the most formal benchmark for the structural gravity model (Equation 4-4), which for all intents and purposes is a form of demand function. Other studies have since then, added different structural elements in an attempt to more accurately reproduce real-world observations (Wilson et al., 2003). These studies have generally dealt with the heterogeneity of goods traded and the price differentials that are encountered with transportation and border costs.

Although economic relationships hold on average, they not hold true as consistently as those of physics. Nonetheless, the gravity model is still able to capture the patterns and regularities of bilateral trade (Shepherd, 2016). It has been used in multiple publications and studies to cover a range of countries, time periods and sectors. Previously the gravity model was only used for the

trade of goods, but more recently in literature it has been applied to the trade of services, which illustrates its versatility as a model (Head & Mayer, 2014).

As mentioned earlier, the standard proxy for supply and demand is the GDP of the exporter and importer, respectively. The larger the exporter's GDP (supply) the more exports there should be and the larger the importer's GDP (demand) the more imports there should be, in theory. However, this is not a perfect science, and as Santos Silva and Tenreyro (2006) have observed, the trade to GDP ratio decreases with increasing total GDP because smaller countries tend to be more open to trade. This may sound confusing but it actually makes sense; trade flows will continue to increase as GDP increases but at a decreasing rate.

Costs that are encountered when trading can include shipping costs, synchronization costs, communication costs, transaction costs, cultural distance, corruption and contract enforceability. The basic gravity model uses distance as a proxy for transport costs. The reason for this is that distance is an indicator of the time elapsed during the shipment of goods and the related financial cost. Distance can also be seen as an impediment to communications and thus the assumption is made that as distance increases so do the transaction costs. The relationship between distance and trade has historically been highly negative. Distance is admittedly not the perfect proxy for trade costs on its own, which is why it is common for other proxies to be included in the equation. Other proxies used for trade costs in the gravity model include: a common colonial history, a common language, a common border, a common predominant religion, a common currency, whether a country is landlocked or not, a common regional trade agreement and institutional quality of the countries. These proxies all to some degree should affect the decision by firms in two countries to trade or not to trade. The gravity model is not perfect but can be augmented and adapted through the use of different proxy variables and dummies; for instance, income per capita can be used to replace GDP. Using income per capita is more indicative of the wealth and development of a country than GDP and it is representative of the capital-labour intensity of a country. A later sub-section of this chapter will cover studies that have included variables for infrastructure, logistics and trade facilitation.

4.3. A Brief Note on the 'Distance Puzzle'

Traditionally a distance variable is used in gravity models as a proxy for transport costs. It is well established that gravity models typically illustrate a negative relationship between bilateral trade and geographical distance (Lin & Sim, 2012), but it is acknowledged that straight line distances do not always accurately represent real world transport distances for various reasons (Head, 2000). Cairncross (1997) was the first to theorise that distance should begin to matter less with the rise of globalisation and improved technology. It would be logical to expect that over time the distance variable has progressively had a less substantial impact on trade flows, as communication technology improves and advances in transportation modes occur (Buehler & White, 2015). However, this is not necessarily the case and in fact certain studies have found that the impact of distance on trade flows is either persisting or in fact increasing (Disdier & Head, 2008; Kano et al., 2013; Berthelon & Freund, 2008). Literature and research, particularly between 2005 and 2015, using log trade flows estimated by ordinary least squares makes note of this, which has now become known as the 'distance puzzle' (Bosquet & Boulhol, 2015). The distance puzzle is the concept that the elasticity of trade to distance has been increasing over time since the 1970s, although communications and transport technology costs are decreasing. One

possible reason for the increase in distance elasticity is the change that has taken place in the composition of trade by industry and the fact that different industries have different sensitivities to distance. Kano et al. (2013) hypothesise that as trade costs are decreasing, certain sectors with higher trade costs and potentially higher distance elasticities are becoming more intensely traded which is skewing the effect of distance to appear more negative than before. In more recent studies, the 'distance puzzle' has been challenged by the use of different estimation techniques and augmented specifications. Carrère et al. (2013) confirm the existence of the distance puzzle but state that it is specific to low income countries and that the relevance of distance to bilateral trade flows is decreasing in high income countries.

4.4. Challenges and Potential Estimation Problems

The number one challenge when working with gravity models is access to reliable trade data. There are many developing nations that do not accurately record their export and import data. Mirror data can be used to account for countries with missing trade data, unless both the countries involved to do not have recorded trade data. Trade data of larger countries tends to be more reliable and of higher quality. As a general rule, it is better to use import data than export data as it is typically more accurately recorded. Governments tend to take more care in knowing what enters their borders than what leaves through them, as imports are normally taxed and are a source of revenue for governments.

Haveman and Hummels (2004) found that almost a third of the bilateral trade data that they were working with was zero values. Ordinary least squares (OLS) is the most frequently used method of estimation for gravity models but this presents a problem when there are zero trade flows present. The logarithm of zero is not defined and as a result the OLS estimation drops all the zero observations in the sample. The complication for Haveman and Hummels (2004) was that this meant that using the OLS estimator would result in a third of their trade data being dropped from the model. The issue with this is that zero trade flows are in their own right pieces of information. Some of the zero values dropped from the model are actually important and could indicate a cease in trade rather than the lack of a trade record. Helpman et al. (2008) determined that half of the country pairs in their sample simply did not trade with each other, which explained the presence of zero trade values in their data set. The omission of zero trade flows can lead to estimation bias. There are a few proposed solutions for dealing with this problem. The first solution is a simple one and only involves adding the value of one to all observations, thus ensuring that all the observations are retained by the model. Head and Mayer (2014) argue that although this is an easy solution to implement, there are better options. The second solution is to use the Heckman Sample Selection method, which is a two-step estimator. Helpman et al. (2008) propose a theoretical two step selection process where exporters absorb fixed costs to enter a market; they suggest a first stage Probit estimation followed by a second stage OLS estimation. From a theoretical point of view, the fixed costs explain why exporters may choose not to trade with another country. The Tobit estimator is another econometric approach that can be used to solve for the zeros and is best suited when small values of trade are rounded to zero. Egger et al. (2011) take a different approach to the problem by using a two-part gravity model. The two-part gravity model allows them to disaggregate the effects of the independent variables on exports converting them into effects on the extensive country margin (Yotov et al., 2016). The last and simplest option is to estimate the gravity model in multiplicative form using the Poisson Pseudo Maximum Likelihood (PPML), as suggested by (Santos Silva & Tenreyro, 2006). It is a theoretically sound

option, which retains the zeros, as the dependent variable is the value of trade rather than the log value of trade. This method, as evidenced by Monte Carlo simulations, works well even when a large proportion of the sample data is comprised of zero trade flows (Santos Silva & Tenreyro, 2011).

A problem with Tinbergen's original gravity model is that it isn't able to cater for multi-lateral resistance. Multi-lateral resistance can be explained as third party effects that affect bilateral trade between countries. An example: if two small neighbouring central European countries were relocated to the middle of the Pacific Ocean, bilateral trade would increase between them due to the change in distance relative to other countries. The lesson from this is that not only the distance between the two countries matters but also the distance relative to all other potential trading partners – multi-lateral resistance isn't just about distance but also applies to changes in costs and factors such as tariffs and free trade agreements of potential alternative trading partners. Multi-lateral resistance terms are non-observable but need to be controlled for, in order to improve the specification of the gravity model. There are a few different available options on how to do so. Anderson and van Wincoop (2003) used iterative custom nonlinear least squares programming to account for multilateral resistances in a static setting. Other authors have tried to use an abridged version of the Anderson and van Wincoop (2003) method by approximating multi-lateral resistance terms by using remoteness indexes which are built as functions of bilateral distance and GDP, but this has been met with limited enthusiasm from the wider economic community. Another option is to remove the resistance terms by using a suitable ratio linked to the structural gravity equation. A potentially better approach is that of Feenstra (2016), who uses directional importer and exporter fixed effects (FE) in cross sectional estimates. In the case of panel data, Olivero and Yotov (2012) accounted for multi-lateral resistance terms by using exporter-time and importer-time FE; the benefit of this method is that it also absorbs all other observable and unobservable country specific characteristics.

Heteroscedasticity which is when the variability of the dependent variable is unequal across the range of an explanatory variable, is a frequently occurring problem in trade data (Yotov et al., 2016). If heteroscedasticity is present and OLS or any non-linearly transformative estimator is used then biased and inconsistent estimates will be produced. The dependent variable can be converted to size-adjusted trade, which only accounts for heteroscedasticity relating to country size. Size-adjusted trade is the ratio of trade to the product of the two countries' GDPs. Alternatively, one can use PPML as the estimator to counter the heteroscedasticity of the trade data (Santos Silva & Tenreyro, 2006).

The endogenous nature of trade policies can make it tricky to produce reliable estimates for the effects of trade policies on bilateral trade. This is because trade policy can be correlated to unobservable cross-sectional trade costs due to reverse causality. Average treatment effect is one of the methods available to address this issue. Non-discriminatory trade policies such as export subsidies are particularly difficult to estimate using a structural gravity model, as they are exporter and import specific which means that they are absorbed by the fixed effects used to solve for multi-lateral resistance. The obvious solution to this, is to use an alternative such as random effects (RE) rather than fixed effects to deal with multi-lateral resistance. Furthermore, when trade policy changes, the impact on trade flow is not immediate but can lag and only be apparent in future years (Olivero & Yotov, 2012). The best way to address this is to use panel data instead of cross-sectional data. The last major issue relating to trade policy is the disaggregation of trade policy due to agreements often being negotiated at a sector level. It is not

possible to aggregate sector specific agreements when looking at total trade of goods and services so the effect of these policies is lost in the model through omission.

Correct specification of bilateral trade costs can prove challenging, but it is imperative for the design of a successful model. The accepted practice is to create a proxy for bilateral trade costs by using a combination of observable variables, most of which are dummy variables. As much as there are multiple challenges faced by the gravity model, there are numerous solutions that can be applied as counters. Authors such as Pfaffermayr (2020) and Anderson et al. (2018) continue to innovate to improve the gravity model, which is evidenced by the continuous publishing of additions to the gravity model literature base.

4.5. Estimation Methods

The estimation of a gravity model requires multiple methodological considerations, including the challenges mentioned in the preceding sub-section of this chapter.

Traditionally, OLS has been the estimation method of choice for the gravity model but as the intuitive gravity model has been subjected to criticism of insufficient theoretical support, so OLS has been under intensified scrutiny as to whether it is the best available option for estimation of the gravity model. Pooled OLS, as an approach assumes no heterogeneity across countries, which means that if the data is heterogeneous there will be bias in the estimation (Qureshi & Tsangarides, 2012). Country fixed effects can be used to counter heterogeneity in both panel and cross section estimation but this does mean omitting variables. Linear regression refers to the linearity of the parameters. Estimates from linear regressions can be difficult to interpret, which can be worked around by doing a logarithmic transformation. A log linear model is easy to interpret as a percentage change in the explanatory variables will mean a percentage change in the dependent variable. To use OLS, the multiplicative gravity model is linearized using logs. The fact that OLS drops zero values is reason for concern, as this is a form of sample selection bias. The regression function would not be using a random sample drawn from the population but rather a sample consisting of strictly positive trade flows. The problem with omitting the zero observations is that they are likely correlated with other variables in the model, resulting in a case of omitted variable bias that violates the first OLS assumption. The concern about omitted variable bias is that the regression will likely produce inconsistent estimates. It is important to ensure that the results from an OLS regression are robust in their application, as otherwise an alternative estimator would likely produce more reliable estimates. The log-linearization of the gravity equation changes the property of the error term, which leads to efficient estimation when heteroscedasticity is present. A fixed effects version of OLS can be used, but issues of heteroscedasticity will still result in exaggerated and biased coefficient estimates (Santos Silva & Tenreyro, 2006). Equation 4-3 is an illustration of a log-linearised model. This specification enables a simple interpretation of the estimated coefficients by using elasticities. The coefficient is the percentage change in the value of the dependent variable following a 1% change in that coefficient's independent variable.

When data is heteroscedastic, it is recommended that a non-linear method of estimation be used. The Heckman Sample Selection (HSS) and the Poisson Pseudo Maximum Likelihood (PPML) estimation methods are both growing in popularity and Shepherd (2016) positions them as suitable alternative estimators to OLS. The PPML model is frequently used when working with

count data. It is important to note that the data does not need to be Poisson distributed or an integer in order for a PPML estimation to be used. The only requirement for the PPML estimator to be consistent is that the conditional mean is correctly specified. It is similar to the Gamma Pseudo Maximum Likelihood (GPML) estimation technique except that it assigns the same weight to all observations. PPML is consistent in the presence of heteroscedasticity and can handle zero values of the dependent variables. Santos Silva and Tenreyro (2006) identify PPML as the easiest method of estimation to use, without requiring further information on the pattern of heteroscedasticity that is present. PPML as an estimator can give consistent estimates of the original non-linear model, as it is the equivalent of having run a non-linear regression. As mentioned before, Poisson models are typically used for count data but because this a pseudo method, it is appropriate for the more general application of non-linear models such as the gravity equation. Equation 4-5 is an example equation for a generic PPML estimation.

Equation 4-5

$$X_{ij} = \beta_0 + \beta_1 \ln(D_{ij}) + \beta_2 \ln(Y_i) + \beta_3 \ln(Y_j) + \beta_A W + e_{ij}$$

X_{ij} is the value of exports between country i and j
D_{ij} is the distance between country i and j
Y_i is the GDP of country i
Y_j is the GDP of country j
W represents the dummy variables included in the particular model
e_{ij} is the error term

Source: Derived from Santos Silva and Tenreyro (2006)

As can be seen in Equation 4-5, the dependent variable in a PPML estimation is in levels, whereas the independent variables are in log form. Despite this, PPML estimations are still relatively easy to interpret as the coefficients can be interpreted in the same way as those of an OLS estimation, as simple elasticities. Other advantages of PPML include that it is consistent in the presence of fixed effects and it includes zero trade value observations in its estimation (Fally, 2015; Shepherd, 2016; Yotov et al., 2016).

There are various advantages and disadvantages to the different estimation methods available for gravity models. Table 4-1 has been adapted from Gómez-Herrera (2013) and conveniently summarises the pros and cons of ten estimation methods, some of which were mentioned earlier in this chapter, and some other methods which will not be discussed in detail.

Overall, the PPML estimation method appears to have the most positive aspects to it, and is simpler to work with than the Heckman two-step estimation, thus making it the estimation method of choice for this study.

Table 4-1 Summary of Available Estimation Methods

Estimation Method	Advantages	Disadvantages
OLS	• Simple	• Can't handle zero trade flows
Truncated OLS	• Simple	• Information is lost through the removal of zero trade flows
OLS (1+T_{ij})	• Simple • Addresses zero trade flows by adding a small insignificant value to all zeros	• Biased coefficients
Tobit Censored Regression	• Simple • Addresses zero trade flows	• Lacks a theoretical foundation
Panel Fixed Effects	• Simple • Controls for unobserved heterogeneity	• Loss of information • Elimination of zero trade flows • Sample selection bias
Heckman two-step	• No multi-collinearity • Has a rationale for zero trade flows	• Can be difficult to find an identification restriction • Exclusion variables are required
PPML (Poisson Pseudo Maximum Likelihood)	• Deals with zero trade flows • Unbiased estimates in the presence of heteroscedasticity • All observations are weighted equally • The mean is always positive	• Limited dependent variable bias when the data is censored
NLS (Nonlinear Least Squares)	• Handles zero trade flows	• More weight is assigned to some variables
FGLS (Feasible Generalised Least Squares)	• Handles zero trade flows • Robust to heteroscedasticity	• A variance covariance matrix needs to be calculated
GPML (Gamma Pseudo Maximum Likelihood)	• Handles zero trade flows	• Less weight to observations with a large conditional mean

Source: Adapted from Gómez-Herrera (2013)

4.6. Augmented Gravity Models

Standard gravity models contain variables for distance, GDP, cultural commonalities, and free trade areas. However, gravity models can be augmented with a number of other variables including those for infrastructure, logistics and trade facilitation. Table 4-2 summarizes previous studies that use an augmented gravity model. The summary covers the focus of the papers as well the estimation technique used and the eventual outcome and findings of each paper.

Table 4-2 Summary of Selected Studies that use a Gravity Model

Author/Date	Topic/Focus	Dataset	Estimation Method	Findings
Limao and Venables (2001)	"The authors use different data sets to investigate the dependence of transport costs on geography and infrastructure."	Cross-section data	OLS – for transport costs Tobit – gravity model for trade flows	Infrastructure heavily influences transport costs, especially in landlocked countries. An analysis of African trade flows indicated that poor infrastructure is a major reason for the continent's relatively low trade flows.
Martinez-Zarzosa and Nowak-Lehmann (2003)	"This paper applies the gravity trade model to assess Mercosur-European Union trade, and trade potential following the agreements reached recently between both trade blocs."	Panel data	OLS, OLS with fixed effects, OLS with random effects	Infrastructure, income differences and exchange rate were found to be important influences on the bilateral trade flows. The importer infrastructure variable was not significant but exporter infrastructure was shown to enhance trade.
Freund and Rocha (2010)	"This paper examines the effects of transit, documentation, and ports and customs delays on Africa's exports."	Cross-section data	OLS	Transit delays have the most economically and statistically significant effect on exports. A one-day reduction in inland travel times leads to a 7 percent increase in exports. Inland travel delays have a larger impact on trade than any other part of the trade chain.

Author/Date	Topic/Focus	Dataset	Estimation Method	Findings
Sun and Reed (2010)	"This paper evaluates agricultural trade creation and diversion effects of the most important free trade agreements."	Panel data	PPML with FE	Agricultural trade has increased amongst members of ASEAN-China preferential trade agreement, EU-15, EU-25, and Southern African Development Community agreement. PPML was found to be a preferred estimator to OLS.
Portugal-Perez and Wilson (2012)	"Estimate the impact of aggregate indicators of 'soft' and 'hard' infrastructure on the export performance of developing countries."	Panel data	Heckman Sample Selection	Trade facilitation reforms improve the exporting ability of developing countries; investment into physical infrastructure and regulatory reform has the greatest positive impact. Transport efficiency and business environment quality have a decreasing marginal effect on exports, as GDP per capita increases. Conversely, infrastructure and ICT have an increasing marginal effect on exports, as GDP per capita increases.
Serrano and Pinilla (2012)	"The objective of this study is to determine the causes of the loss of share of agricultural products and food in international trade."	Panel data	OLS, OLS with fixed effects, OLS with random effects	International trade growth of agricultural goods and food is slow because of low demand elasticity, high levels of protectionism, and a relatively small share of intra-industrial trade.
Akpan (2014)	"This study employs the gravity model of trade to examine the impact of improving the quality of a regional road	Panel data	OLS RE	If the average quality of the road increases by 1 per cent, on average, intra-regional export will increase by US$0.91 million.

Author/Date	Topic/Focus	Dataset	Estimation Method	Findings
	infrastructure in the ECOWAS sub-region, from its current level to the level of roads in South Africa, on intra-regional trade."			
Jordaan (2014)	"This paper, using an augmented gravity model, examines trade facilitation factors that impact on South Africa's exports to other selected African countries."	Panel data	OLS FE	Improving customs efficiency within the importing country has the largest positive effect on trade. Regulatory and environment and domestic infrastructure are the next most important factors for increasing trade. Contiguity between countries and having a common language impact had a positive impact on South African exports.
Bensassi et al. (2015)	This paper estimates an augmented gravity model of trade that specifically includes logistics and transport infrastructure indicators as explanatory variables.	Panel data	Mundlak approach with bilateral random effects and time fixed effects	Logistics is shown to be important for trade flows in goods. The study highlighted that the number, size and quality of logistics facilities positively influence export flows.
Bottasso et al. (2018)	The authors "analyse the impact of port infrastructure on trade by estimating a gravity equation for exports (imports) of Brazilian states towards (from)	Panel data	PPML	An increase in port infrastructure was found to be associated with substantial increases in Brazilian exports but the influence of port infrastructure on imports was more mixed and generally had a smaller impact.

Author/Date	Topic/Focus	Dataset	Estimation Method	Findings
	all main Brazil's trading partners."			
Takele (2019)	"The main objective of this article was to analyse the effect of trade logistics performance on the intra-regional trade of Africa."	Panel data	Heckman maximum likelihood estimation (with a robust option)	Improvement in any of the LPI components can lead to significant growth in the trade between African countries.

Each of the studies included in Table 4-2 are of interest to this study, as they use gravity models with various estimation methods to study the effects of trade logistics on trade. The overarching theme amongst these papers is that OLS is still a popular method despite its shortcomings, but PPML and Heckman's Sample Selection are becoming more prevalent. Panel data appears to be used more frequently than cross sectional data for these types of studies, especially in more recent years. The disadvantages and advantages of panel data will be discussed in Chapter 5. All of the studies listed in Table 4-2 that used gravity models augmented with a trade logistics variable found that improved trade logistics had a positive impact on trade, regardless of the proxy used.

4.7. Aggregated and Disaggregated Trade Data

As mentioned earlier in this Chapter, GDP is typically used both as a proxy for supply and as a proxy for demand. However, GDPs are not always good proxies, especially when a study is specific to a certain sector or group of goods. Typically, larger countries produce a greater variety of goods and this increases their trade on the extensive margin so an increasing GDP does not necessarily indicate greater trade flows for a particular segment but rather just generally a greater flows of goods (Hummels & Klenow, 2005). As economies grow so their trade can expand either on the intensive or extensive margin, which means that on occasion the GDP variable can be found to be insignificant in a sector specific gravity model.

Most gravity models are estimated at an aggregate level, in which case there is no problem, but as soon as one works with disaggregated goods in a gravity model then caution should be advised (Cirera et al., 2016). French (2011) is able to show through a simple framework that aggregate trade flows have a level of dependence on the composition of a country's production and consumption across products, which varies across countries. In other words, trade cost estimates that are based on aggregate data are biased and can result in misleading estimations. At a disaggregated level, comparative advantage begins to play a role in the supply of goods, therefore Cirera et al. (2016) suggest using production of goods in the exporting country and consumption of those goods in the importing country to approximate supply and demand respectively, in order to ensure correct specification. Some authors still use GDP despite its leading to incorrect specification in a disaggregated model, but French (2011) proposes an alternative approach

where the total sector exports for the exporting country is used as a proxy for supply and total sectoral imports for the importing country are used as a proxy for demand (Cirera, et al., 2016).

4.8. Conclusion

Chapter 4 was included to provide the theoretical background and understanding required to run a gravity model. The chapter covered the basic literature on gravity models and explained how the gravity model has evolved from an empirical framework in 1962 into a fully-fledged theoretically grounded model today. The distance puzzle is briefly considered and noted.

The various challenges and potential estimation problems of using a gravity model are then considered, before going through the various options of estimation methods. Each type of estimation method that can be used with the gravity model has advantages and disadvantages. OLS has traditionally been the 'go to' estimator for gravity models, but the use of the Heckman Selection Sample and PPML methods are growing in popularity. The purpose of this sub-section was to show why the PPML was selected as the most appropriate choice of estimator for this study's gravity model. The main advantages of the PPML estimation are that it deals with zero trade values and heteroscedasticity.

A table of examples of literature that has used gravity models to investigate the influence of trade logistics on trade is provided, as an easy reference. The table also shows that over time certain estimation methods such as the Heckman sample selection method and PPML have become more popular.

The chapter closes out by discussing the prevalence of aggregated data gravity models over disaggregated ones and how to ensure that disaggregated models are properly specified for in terms of proxies for supply and demand. This discussion lead to the author deciding to use total agricultural goods imported and exported as proxies for demand and supply in this study's gravity model.

The next Chapter will continue to build on the theory from this chapter and show the practical application and design of this study's gravity model. It outlines the specification of this study's gravity model and the method involved to produce results that inform whether trade logistics, as captured by the LPI, influences the intra-African trade of agricultural goods or not.

5. The Practical Application of the Gravity Model

5.1. Introduction

The previous chapter covered the theory behind the gravity model and the various methods for estimation. This Chapter will follow the basic methodology for econometric analysis, as outlined by Gujarati and Porter (2010), although not necessarily in the exact order. The sections of this chapter are broken down into the following:

1. Hypothesis/statement of theory
2. Collecting data and building a database
3. Estimation method
4. Model specification and expectations

5.2. Hypothesis

Literature, including the studies of Bottasso et al. (2018), Marti et al. (2014), Takele (2019), Bensassi et al. (2015), Christ and Ferrantino (2011), Portugal-Perez and Wilson (2012) and Freund and Rocha (2010), suggests that improvements in trade facilitation should lead to increased trade between countries, as a result of decreased cost and increased reliability of delivery of goods. Agricultural goods can be perishable in nature and therefore the time it takes to transport the goods, which has ramifications on the quality of the goods and therefore their trade-ability and profitability. Consequently, it would make sense that trade logistics has an even larger impact on the trade of agricultural goods than other non-time sensitive categories of goods. The level of trade-supporting infrastructure and transport efficiency in Africa, as outlined in Chapter 3, is relatively low compared to other regions around the world. Portugal-Perez and Wilson's (2012) findings show that the marginal effect of transport efficiency and the business environment on exports decreases as a country's income per capita increases, whereas the marginal effect of physical infrastructure and information and communication technologies on exports increases as GDP per capita increases. Based on these findings it would be logical to assume that logistics quality should have a substantial impact on trade in Africa, where most countries have relatively low GDP per capita compared to other regions around the world (IMF, 2019).

The hypothesis for this study is that the level of trade of agricultural goods amongst African countries increases when the logistical quality of the exporting and importing countries increases.

5.3. Building the Database

Gravity equations can be estimated for either panels of countries or cross-sections – this study makes use of panel data. Traditional gravity models up until the 1990's typically used cross-sectional datasets (Westerlund & Wilhelmsson, 2006; Olivero & Yotov, 2012). However, the use of panel data, also known as cross-sectional time series data is now more popular due to the number of advantages that it offers (Table 4-2).

Baltagi (2005) lists the following advantages of using panel data:

- It controls for individual heterogeneity
- It gives more informative data, more variability, less collinearity amongst the variables, and more degrees of freedom
- It better enables the study of the dynamics of adjustment
- It is better able to identify and measure effects that are not detectable in pure cross-sectional or time series data
- It allows one to construct and test more complicated behavioural models

Baltagi (2005) also names the various challenges involved with using panel data:

- Design and data collection problems
- Distortions of measurements errors
- Self-selectivity
- Short time series dimension
- Cross section dependence

With panel data, the behaviour of a variable is observed across time, thus allowing one to mitigate the bias of country heterogeneity, whilst establishing the effect of time invariant variables and country specific effects. One is able to capture relationships between variables over time. Fixed effects can be used when one is focused on only the variables that differ over time. With random effects models, variation across entities are considered to be random and uncorrelated with the independent variables in the model. Data collection can be problematic when constructing a panel data set, as data is not always available for every year for every country. However, this problem can be overcome by using logical assumptions to estimate for missing data. The model in this study makes use of a panel dataset.

Panel data tends to be more informative and increases the efficiency of estimators (Serrano & Pinilla, 2012). If panel data is used, as is the cases with this study, the number of observations will be Tn(n-1). T is the number of time periods covered by the panel and n is the number of countries. In general, the larger the data sample, the more precise the estimates will be. Panel data has a clear advantage over cross section data, in that it avoids bias that can be caused by heterogeneity across countries. In a cross-section model, one is unable to control for anything other than country pair characteristics. However, panel data analysis allows for multiple observations of the same country across a time period (Liu et al., 2020).

A time period of 2010-2018 is considered in the gravity model. The reason for this limitation is practical, to keep the data set a manageable size. The period has also been chosen to align with the data that is available for the LPI – this data is updated every two years by the World Bank. Data for five years (2010, 2012, 2014, 2016 and 2018) is used in the gravity model. The focus of the study is on intra-African trade. All 54 African countries were initially considered but the eventual sample contained 38 African countries as trading partners for the gravity model. The 38 countries were selected purely based on data availability (Table 9-2). Given the 5 years and 38 countries, the balanced dataset used in the gravity model included 7030 observations.

The study only considers the trade of agricultural goods, which are goods that originate from crops or animals. Tobacco products as well as agricultural products not fit for human consumption were excluded from the dataset. For the purpose of this study, agricultural goods have been defined

as the Harmonized System (HS) chapters included in Table 9-3. The decision was taken to work at an HS Code Level 2 in order to reduce unnecessary complexity.

Estimating a gravity equation initially requires data collection and organization. Data availability is consistently a central issue, when working with developing countries (Moïsé et al., 2013). Data compilation can be a time-consuming process, as normally gravity models require a large database of information. The benefit of this is that the larger the sample of data generally the more precise and stable the results are. The quality and quantity of data is crucial, as poor quality or too small a sample size can invalidate the model. A primary challenge in building a database for a gravity model is the fact that data is collected from various sources and then needs to be merged into a single database. Working with varying formats and classifications of data can prove challenging, and was most certainly the case for this study. The variety of data sources can be seen in Table 5-1. An extensive amount of work was required to format, manipulate and merge the data in Excel, making use of pivot tables, filters, index and match functions, complex if functions, vlookup functions, unpivoting of tables and more to eventually arrive at a consolidated data set.

Certain countries have inaccurately recorded data. This includes instances where zero trade is reported but this does not necessarily mean that no trade took place. This has been especially problematic in this study, as the sample is limited to Africa and African countries are notorious for poor reporting standards. In this study import data was used instead of export data. Import data is typically better recorded and more accurate because imports generate tariffs, which means there is incentive for better collection of this data by countries to ensure that these tariffs are being paid (The World Bank, 2010). Export data has a reputation for being less well reported. The importer in this study is also the reporter country and the exporter is recorded as the partner country. The terms importer and reporter will be used interchangeably, and the terms exporter and partner will be used interchangeably. Mirror data was used in instances when no import data was available for supply and/or demand of a country included in the dataset. Mirror data is not a perfect reflection, as export values are recorded as fob (free on board), whereas import values are recorded as cif (cost insurance and freight) by UN Comtrade, which leads to some variations between the values when matched against each other (The World Bank, 2010).

Some data assumptions had to be made where data was missing. In cases where LPI data was missing for a specific year for a country, the previous year's data was used if possible and if that wasn't possible, the following year's data was used. This approach although not hugely accurate was more realistic than leaving a value blank and was deemed acceptable because the LPI score of a country typically doesn't change significantly within a 2-year period. There were some African countries that had no LPI data. Examples of countries were excluded from the data set on that basis are Eswatini, Comoros, Seychelles and Cabo Verde. In the case of exchange rates, wherever the average exchange rate wasn't available for a given year that line of data was populated as a dummy pairing. Although the World Bank's world development indicators data set didn't have an exchange rate for Zimbabwe, an assumption was made that because Zimbabwe used the USD from 2009-2018 its exchange rate metric was given a value of 1 in the dataset. Where countries were missing exchange rate data an assumption was made regarding whether the partner country had a larger local currency value per US$ than the reporter country based on data available for other years – see an explanation of the exchange dummy variable in Table 5-1.

5.4. Choice of Estimation Method

As discussed in the previous chapter, the gravity model is a well-established econometric model which has been theoretically and empirically validated. The primary use of the gravity model is to measure bilateral trade flows and determine patterns of trade. It is a relatively easy to use model and has limited data requirements, thus making it the model of choice for this study.

Ill-chosen approaches to estimation result in biased results (Head & Mayer, 2014). The traditional procedure for estimating a gravity equation is to take the natural logarithms of all variables and to obtain a log-linear equation that can be estimated by ordinary least squares regression. The logarithmic transformation of the variables is done so that the coefficients can be interpreted as elasticities. However, this causes problems with zero trade flows. Following investigations into the various estimation options discussed in Chapter 4, a decision was made regarding which estimator to use in this study. PPML with fixed effects (FE) was selected as the main estimation although Poisson estimations with both FE and random effects (RE) are to be run and compared. The PPM with FE was selected based on its growing popularity in literature and its ability to deal with heteroscedasticity and zero trade flows, whilst remaining relatively easy to interpret. Typically random effects models allow for the estimation of coefficients of time variant variables, whereas fixed effects models do not (Prehn et al., 2016).

For both Poisson and PPML models the dependent variable in the estimation is in levels and all non-dummy independent variables are in log form (hence the ability of the models to deal with zero trade flows). The fact that PPML gives consistent estimates for the time varying variables irrespective of fixed or random effects indicates that the bias as result of heteroscedasticity has been dealt with, whereas in an ordinary panel fixed effects estimation, the results suffer from heteroscedasticity. The estimations for this study were run using StataCorp's statistics and data software (STATA). A panel data PPML is simple enough to run in STATA using the ppml command. The xtpoisson command for the Poisson model with FE or RE can struggle with large values so it is prudent to scale variables that have large values as observations, such as population or GDP considering that Poisson regressions will be run to compare against the PPML with FE. Care should however be taken, as the model is not scale-invariant with regard to the dependent variable when scaled values become less than 1. In this study the values for supply of agricultural exports and demand for agricultural imports were included in USD millions to avoid problems with the xtpoisson command, but trade values (dependent variable) were included as USD thousand because these values were notable smaller and hence trade values in USD millions caused inconsistent results due to scaling issues.

5.5. Model Specification and Expectations

In practice, a good econometric model will be parsimonious and not be over specified and the parameters of the model will be uniquely identifiable. Theoretical consistency is important for a model; the coefficients that are estimated should have signs consistent with what the theory predicts, but there can be exceptions. The predictive power of the model is important as a model with strong predictive power can produce reliable forecasts. There should be a reasonable goodness of fit, meaning that the independent variables explain most of the variation of the dependent variable – this can be compared across nested models using the log likelihood value. The log likelihood value has no meaning itself but can be used to assist when comparing models

that contain more or less independent variables in relation to each other (UCLA: Statistical Consulting Group, 2020).

Specification errors need to be avoided when designing a good model. Omitting relevant variables, including unnecessary variables, using the incorrect function form, violating either the assumption of heteroscedasticity or no autocorrelation, and errors of measurement all lead to errors in specification. A good model will only include the core variables and all the smaller influences will be covered by the error term. On this basis, choosing the right independent variables to include in the model is an important part of the modelling process. Correct specification is crucial in ensuring unbiased results. The variables chosen for this study's gravity model are listed in Table 5-1. The table includes details about each variable.

Looking at literature, GDP and geographic distance between the trading country pairs are key economic variables for gravity models but there are other variables such as indicators of trade facilitation that can be used to augment the model (Wilson et al., 2003). Distance between the importing and exporting country is a standard variable to include in a gravity model, as explained in the theory sub-section of Chapter 4. It was decided that despite the majority of literature it would be better to follow French's (2011) approach to use the total exports and imports of agricultural goods of each African country as a respective proxy for supply and demand in this model, instead of the GDP of the exporter and the importer. The reason for this is that the total exports and imports of agricultural goods are sector specific and take into account comparative advantage, whereas GDP does not, therefore the replacement of GDP with total imports and exports of agricultural goods should reduce misspecification in the model. GDP is a more general indication of overall supply and demand of goods and its use in a model that is specifically looking at trade of agricultural goods, could lead to misspecification – the theory behind this was discussed in the latter part of Chapter 4. Literature suggests that the trade data and any GDP observations used in a gravity model should be in nominal terms (Shepherd, 2016), this suggestion was adhered to in this study.

In Chapter 1, it was initially established that the quality of infrastructure and other trade logistics factors can influence bilateral trade volumes. Chapter 3 then provided a deeper look at the current state of trade logistics in Africa and its role in the export process. Overall, the literature available suggests that the logistics quality of countries should influence their level of trade with each other. For this reason, the gravity model was augmented with a variable for trade logistics quality. The World Bank's international LPI score is chosen over the global competitiveness index and the World Bank's ease of doing business score to be used as the proxy for trade logistics quality in this study's gravity model. An average of the LPI scores of the importing and exporting countries was used as the proxy for trade logistics in each observation.

Dummy variables chosen for this model cover: common language, common regional economic community, contiguity, currency strength and whether or not a country is landlocked. Transport costs are typically higher for landlocked countries than other countries (Venables & Limão, 2002; Moore, 2018), thus it was deemed relevant to have a dummy for whether the exporting countries are landlocked or not. Exchange rate policies and exchange rate stability can affect trading costs between countries (Qureshi & Tsangarides, 2012). The soft and hard pegging of a currency can influence its level of stability. Some African countries such as members of WAEMU have a common currency, the West African CFA franc which is pegged to the Euro and supported by the French treasury. Lower volatility and a stable exchange rate can reduce trade costs borne out of

uncertainty. Exchange rates are only relevant in gravity models, when panel data is used and a time dimension is included in the model (Martinez-Zarzosa & Nowak-Lehmann, 2003). In the case of this model, the exchange rate variable is not the exchange rate between the two countries in question, but rather the difference in their exchange rate with the USD, which is used to create a dummy for whether the importer or exporter has a stronger currency. A significant exchange rate coefficient would indicate that price competitiveness plays a role in determining bilateral trade flows. The dummies for social distance were included based on literature that has continuously proved them to be factors that affect trade. A dummy for membership to a common regional economic community was included due to indications from the literature that it would currently be an important factor for intra-African trade. The common REC dummy works as a proxy for trade agreements. However, once the AfCFTA is in place and is fully operational the influence of the RECs on intra-African trade may diminish. As discussed in Chapter 2, African countries have a propensity to trade with their neighbours, therefore it made sense to include a dummy variable for contiguity (shared land borders). Contiguity can have a strong influence on trade due to the short distance between countries, the higher probability that social distance is minimal and the fact that there is only one border that the goods have to cross which reduces administrative costs and time required to move the goods from the seller to the buyer. A ‘common official language’ dummy variable was included to capture the effects of how easy or not it will be for firms in the two countries to communicate and organise sales and purchases of goods.

The principle of Ockham’s razor was applied. The principle of Ockham’s razor is that simplicity is best until proven inadequate. The relevance of this is that the regression should be kept as simple as possible, meaning that the extraneous inclusion of variables is avoided. Additional variables are excluded on the premise that their cumulative influence on the dependent variable is small and non-systemic enough to be included in the random error term instead (Gujarati & Porter, 2010). There were some other variables that were considered for this model, but either due to lack of availability of data or for theoretical reasons these variables were deemed unnecessary and left out. Examples include the World Bank’s governance indicator for ‘Political Stability and Absence of Violence/Terrorism’, a dummy for whether the importing country is landlocked or not and a common historical coloniser dummy variable. As mentioned in Chapter 2, institutions, corruption and political stability can have an influence on trade. There were difficulties in sourcing data to use for a variable that could be used as a proxy for these influences, and when looking at Africa’s corruption ratings in general the majority of countries had poor scores. African countries generally do not have large discrepancies in terms of corruption ratings, unlike if you compared African countries to countries on other continents. Thus, taking into consideration that this model is looking specifically at trade between African countries, this variable seemed less important and less likely to actually influence choices in terms of trading partners. A landlocked dummy variable was not included for importing countries, as it was decided that importing countries would likely import irrespective of whether they are landlocked or not. Another variable that was excluded from the model was a dummy for a common coloniser. Although sharing a common coloniser may have influenced bilateral trade flows historically, Head et al. (2010) found that after 40 years of independence, trade between countries that had a common coloniser has decreased by almost 65%. On this basis of reduced influence, it was decided to exclude the common coloniser dummy from the final specification of the gravity model.

The random error term accounts for all those independent variables that may have an influence on bilateral trade but are not explicitly included in the model.

Equation 5-1 has been formulated based on the specification and regression decisions made thus far. The time period, t, has been chosen based on data availability for LPI. All other data was matched to these years. The data sample contains 5 sets of observations spanning 10 years, a set every 2 years is included thus the years under consideration are: 2010, 2012, 2014, 2016, 2018. Equation 5-1 is the log linear equation for this paper's model based on panel data.

Equation 5-1

$$X_{ij} = \beta_0 + \beta_1 \ln(D_{ij}) + \beta_2 \ln(Y_i) + \beta_3 \ln(Y_j) + \beta_4 \ln(LPI_{ij}) + \beta_A W + e_{ij}$$

The variables are explained in the table below. *W* indicates the dummy variables.

Table 5-1 Summary of Variables Chosen for Inclusion in the Gravity Model

Variable	Variable Name	Variable Description	Variable Type	Data Source
X_{ij}	Import Value	The USD (thousands) value of agricultural goods exported from country i to country j	Dependent	International Trade Centre[1]
D_{ij}	Distance	The straight-line distance between the reporter and partner country (km). Geodesic distance calculated using the great circle formula/ Most populous city to most populous city. The distance formula used is a generalized mean of city-to-city bilateral distances developed by Head and Mayer (2002), which takes the arithmetic mean and the harmonic means as special cases.	Independent	French Research Centre in International Economics (CEPII)
Y_i	Exporter Supply	The total exports of agricultural goods by the partner country in USD (m)	Independent	International Trade Centre
Y_j	Importer Demand	The total imports of agricultural goods by the	Independent	International Trade Centre

[1] All trade data that was extracted from the International Trade Centre website was searched for 'by country' rather than on a 'by product' basis. This is important to note as the use of different search criteria can result in differing trade figures due to the nature of how trade data is recorded.

Variable	Variable Name	Variable Description	Variable Type	Data Source
		reporter country in USD (m)		
LPI_{ij}	Average LPI	Average logistics performance index score for country i (exporter) and country j (importer).	Independent	World Bank – Logistics Performance Index
$exchange$	Exchange Rate	Does the partner have a larger local currency value per US$ than the reporter? I.e. does that partner have a weaker currency than the reporter? Yes =1 No =0	Dummy	World Bank - World Development Indicators
$contig$	Contiguity	Do the reporter and partner share a common border? Yes =1 No =0	Dummy	French Research Centre in International Economics (CEPII)
$land_i$	Exporter Landlocked	Is the partner country landlocked? Yes =1 No =0	Dummy	French Research Centre in International Economics (CEPII)
$c\_offlang$	Common Official Language	Do the reporter and partner share a common official language? Yes =1 No =0	Dummy	French Research Centre in International Economics (CEPII)
c_rec	Common Regional Economic Community	Do the reporter and partner belong to the same regional economic community? Yes =1 No =0	Dummy	United Nations Economic Commission for Africa website and individual REC websites
$\beta_A W$	Dummy variables	Used as short hand for the group of dummy variables, when writing out the equation	Dummy	Multiple
e_{ij}	Error Term	Standard error term		

Table 5-2 summarises the predictions for the independent variables' coefficients. Distance is expected to have a negative relationship with bilateral trade volumes. This expectation is supported by literature, as an increase in distance typically results in an increase in trade costs

and time required for transport. The dummy variables for whether the exporter is landlocked is also predicted to have a negative relationship with trade volumes. If a country is landlocked it should be more difficult to export goods at a competitive rate due to transhipment difficulties and higher transport costs with no direct access to sea ports. The supply and demand proxies should both have positive coefficients. Theoretically, the larger the supply of goods, the more goods there are available to trade and the larger the demand, the more goods will be bought to satisfy demand, therefore both driving up trade volumes. The estimated coefficient of the LPI indicator should have a positive sign, based on the literature. As logistics quality improves in either an importing or exporting country, the level of trade flow should increase as well, as it becomes cheaper and quicker to move goods. It is anticipated that the exchange rate dummy will have a positive coefficient. When the importing country has a stronger currency than the exporting country, the importing country will have more buying power than if it was importing from a country that had a stronger currency. In general, the easier it is to communicate, the easier it should be to do business. A common language enables more complex discussions and can allow for better planning and negotiating between firms in different countries leading to more sales, which results in more trade. On this basis it is expected that the dummy variable for common official language should have a positive sign. The coefficient for the common REC dummy variable is also projected to be positive. Belonging to a common REC should mean that the countries have some form of preferential trade agreement in place, thus making it likely that their trade volumes will be higher than if one of them was not part of the REC.

Table 5-2 Predictions for Independent Variables Coefficients

Variable	Predicted Coefficient Sign	Supporting Literature Examples
$\boldsymbol{D_{ij}}$	Negative	Lin and Sim (2012)
$\boldsymbol{Y_i}$	Positive	Hummels and Klenow (2005)
$\boldsymbol{Y_j}$	Positive	Saslavsky and Shepherd (2012)
$\boldsymbol{LPI_{ij}}$	Positive	Limão and Venables (2001) Martinez-Zarzosa and Nowak-Lehman (2003) Bottasso et al. (2018) Liu and Yue (2013) Jordaan (2014) Martincus et al. (2015)
$\boldsymbol{exch}$	Positive	Martinez-Zarzosa and Nowak-Lehman (2003)
$\boldsymbol{contig}$	Positive	Davids et al. (2016) Jordaan (2014)
$\boldsymbol{land_i}$	Negative	Hallaert et al. (2011) Moore (2018)
$\boldsymbol{c\_offlang}$	Positive	Egger and Toubal (2018) Jordaan (2014)
$\boldsymbol{c\_rec}$	Positive	Sun and Reed (2010)

5.6. Conclusion

This chapter followed the standard textbook methodology of Gujarati and Porter (2010), which was used as a guideline. The purpose of this chapter was to explain the design of the gravity model that is used in this study. The chapter was also used to remind the reader of the research objectives and the hypothesis for the study. It was hypothesised that the logistics quality of the exporting and importing countries will have a positive relationship with the level of trade between the two countries. The building of the database for the model was discussed. Data compilation for this study was strenuous and required data formatting and manipulation in Excel in order to generate a single merged data set. The choice to use a PPML estimation method was then explained before the model specification and predictions for the estimated coefficients of the independent variables were shared. Overall, the purpose of this chapter was to show the practical application the gravity model as a precursor to the results chapter.

The next chapter covers the results of the gravity model, which will be key in addressing the main research objective. It opens with a summary of descriptive statistics for the data set before giving the results of the three estimations that were run. The various output values are discussed and interpreted accordingly, before a concluding view is given on the model and what it means for the intra-African trade of agricultural goods.

6. Model Results

6.1. Introduction

Statacorp (STATA) is the statistical software that was used to run the various estimations. In Table 6-1 the naming conventions that were used when estimating the model in STATA are provided to make it easier to read the results outputs in this Chapter.

Table 6-1 Variable Names used in STATA and Corresponding Variable Names from Table 5-1

Variable name used in STATA	Variable name in Table 5-1
importst	Import Value
dist	Distance
supplym	Exporter Supply
demandm	Importer Demand
lpi	Average importer and exporter country pair LPI
exchange	Exchange Rate
contig	Contiguity
pland	Exporter Landlocked
colang	Common Official Language
crec	Common Regional Economic Community

The flow for the rest of the Chapter is as follows. Firstly, an overview of the variables is given with a summary of descriptive statistics for the non-dummy variables. The percentage split of the dummy variables is also discussed in the next section. Then the correlation coefficients of the non-dummy variables are considered and explained. Lastly, the estimation outputs are presented and discussed.

6.2. Summary of Descriptive Statistics for the Gravity Variables

Table 6-2 is a summary of descriptive statistics for the independent variables used in the gravity model, excluding the dummy variables which will be dealt with separately. The maximum level of imports by one country from a trading partner in a single year was USD 663000 thousand, but imports also went as low as zero. The shortest distance between two trading countries was 105.1km but countries up to 9096.8km away from each other participated in trade. The average LPI score was 2.52. As a reminder, the LPI score is measured on a scale of 1-5. The mean total exports of agricultural goods by the partner country was USD 965m, while the mean total imports of agricultural goods by the reporter country was USD 1385m. As discussed towards the end of Chapter 4, French (2011) proposes using total sector exports for the exporting country as a proxy for supply and total sectoral imports for the importing country as a proxy for demand, rather than GDP, in order to improve model specification. French's (2011) approach has been followed in this gravity model. It is worth noting again that the model is not scale-invariant with regard to the dependent variable. The trade values (dependent variable) were kept in USD thousands but the independent supply and demand variables were used in USD millions – see Chapter 5 for further detail on the rationale behind this.

There were 4505 import observations in the data set, however one will see that in Table 6-2 that the other variables have 7030 observations. The discrepancy been the two is illustrative of the fact that there is missing trade data in the sample. In 53.27% of the observations, the importing country had a weaker currency than the exporting country. In 34.21% of the observations, the exporting country was landlocked. In 46.09% of the observations the trading partner pairs shared a common official language. In 8.53% of the observations the importing and exporting countries shared a border. Africa's RECs as mentioned in Chapter 2, frequently have overlapping memberships; in 43.10% of the observations the importer and the exporter belonged to the same REC.

Table 6-2 Summary of Descriptive Statistics for Non-dummy Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
importst	4,505	7180.201	38011.91	0	663243
dist	7,030	3542.493	1880.804	105.1806	9096.822
lpi	7,030	2.52607	.2463878	1.474167	3.553308
supplym	7,030	965.8132	1705.821	.003	8925.465
demandm	7,030	1385.681	2195.588	29.127	11883.58

6.3. The Model Results

Three different estimations of the model were run. Firstly, a Poisson regression with random effects (RE) was run using the xtpoisson command in STATA. Then a Poisson regression with fixed effects (FE) was run because fixed effects are deemed relevant in this context due to the panel nature of the data. The FE Poisson estimation's outputs are comparable with the FE PPML estimation's outputs. The FE PPML regression was run using the ppml command as a third estimation to compare with the fixed-effects Poisson. The FE PPML is deemed the correct specification taking the panel nature of the data into account as well as recent literature, and is therefore expected to provide the most realistic results out of the three models. The results for all three estimations are shown in Table 6-3. Country pair and year dummies were used in both of the FE models.

The main difference between the two Poisson models is that the FE version drops the time invariant variables from the estimation, whereas the RE version retains the time invariant variables. The RE Poisson model results are therefore presented because it is useful to determine whether the signs of the estimated coefficients for the time invariant variables are also according to expectation. Due to the fact that import data was missing, 2525 observations were dropped automatically by the RE Poisson model, as evidenced by the difference in number of observations for imports listed in Table 6-2 compared to the number of observations indicated in Table 6-3. Comparatively the two FE models dropped 5 variables and an additional 572 observations.

As was discussed in Chapter 4 and Chapter 5, there was an option to use GDP instead of total agricultural exports and total agricultural exports as proxies for supply and demand. A PPML FE estimation was run using GDP and the results for this can be seen in Table 9-4 in the appendix. The results for this model were not particularly useful as only the importer's GDP was significant

at the 10% level. This provided confirmation that using total agricultural exports and total agricultural imports as proxies for supply and demand in the main model was the correct decision.

Table 6-3 Estimation Outputs

VARIABLES	(1) Possion_RE importst		(2) Possion_FE importst		(3) PPML_FE importst	
	Coefficient	**P>|z|**	**Coefficient**	**P>|z|**	**Coefficient**	**P>|z|**
lndist	-0.420**	0.043				
	(0.207)					
lnsupplym	0.358***	0.002	0.401***	0.001	0.401***	0.000
	(0.113)		(0.124)		(0.920)	
lndemandm	0.738***	0.000	0.820***	0.000	0.820***	0.000
	(0.114)		(0.121)		(0.102)	
lnlpi	0.0121	0.968	0.275	0.411	0.275	0.336
	(0.303)		(0.335)		(0.286)	
exchange	0.105**	0.014	0.132***	0.000	0.132**	0.022
	(0.043)		(0.034)		(0.058)	
pland	-1.203***	0.000				
	(0.274)					
colang	0.255	0.333				
	(0.263)					
contig	2.011***	0.000				
	(0.294)					
crec	1.710***	0.000				
	(0.257)					
Constant importst	2.566	0.128				
	(1.684)					
Constant					-3.322***	0.002
					(1.078)	
Observations	4,505		3,933		3,933	
R-squared					0.968	
Number of pairnum	939		819			

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6.4. Interpretation of the Model Results

Starting with the suitability of the models as a whole, one can look at the log likelihood value and the Prob > chi^2 value for the two Poisson estimations. The log likelihood value has no meaning itself and because nested models are not being compared it can be disregarded. Although two Poisson models have been shown in Table 6-3, both models contain the same variables and thus no reasonable comparison can be made using the log likelihood value. The Prob > chi^2 value is less than 0.01 for both of the Poisson models which means that the overall models are significant at the 1% level. The R squared value for the PPML FE model is an indicator of how well the

independent variables in the model explain the changes in value of the dependent variable. The R squared value in this case is 0.968, which is very high.

The first step to interpreting the coefficients of the variables in Table 6-3 is to establish which of them are statistically significant. Favouring the benchmarks used most widely in literature, this study will consider results to be significant at the 10% level or better, which requires a p value < 0.1. A variable is considered significant at the 5% level if the p value is < 0.05 and if the p value is < 0.01 then the variable is significant at the 1% level. In the RE Poisson estimation all of the variables were significant at the 10% level except for the LPI variable and the common official language dummy. A FE Poisson regression was then run because it is deemed the more correct specification. The p value of the LPI variable improved from 0.968 to 0.411 but LPI remained insignificant at the 10% level. Due to the benefits of PPML over other methods of estimation, a FE PPML estimation was run to compare against the FE Poisson estimation. The LPI variable's p value improved further to a level of 0.336 but remained insignificant at the 10% level. The three other time variant variables of supply, demand and exchange rate were all significant at the 1% level for the FE Poisson estimation, although in the FE PPML estimation the exchange rate dummy was only significant at the 5% level. In the RE Poisson regression, distance and exchange rate are significant at the 5% level and the rest of the variables excluding common official language and LPI, were significant at the 1% level. All of the coefficient signs for the dummy variables and other independent variables were predicted accurately across all three models (Table 5-2 and Table 6-3).

The most important variables in the model are those that form the basis of the intuitive theory of the gravity model. The distance between countries and the size of their economies or in this case the level of the imports and exports of agricultural goods (which are a more accurate representation of supply and demand) are the key variables in this model. The estimated coefficients for the natural log of supply, demand and distance across all 3 models had the expected signs, as per the predictions in Table 5-2 and were of statistical significance, which lends credibility to the estimations of the coefficients of the other variables in this gravity equation.

The coefficients of the significant quantitative independent variables can be interpreted using simple elasticities. The dummy variables on the other hand require a conversion before they can be interpreted as elasticities. Equation 6-1 is a generic example of the conversion and Equation 6-2 is a worked example for the exchange rate dummy variable in the FE PPML model.

Equation 6-1

$$((e^{dummy\ coefficient}) - 1) \times 100 = \%$$

Equation 6-2

$$((e^{0.132}) - 1) \times 100 = 14.11\%$$

Table 6-4 gives the interpretations of the coefficients for each independent variable included in the three models. The PPML FE model's results will be further discussed in the next section of this chapter.

Table 6-4 Interpretation of the Coefficients

Variable	Poisson RE	Poisson FE	PPML FE
lndist	**A 1% increase in distance will lead to a 0.42% decrease in imports		
lnsupplym	***A 1% increase in supply will lead to a 0.36% increase in the value of imports.	***A 1% increase in supply will lead to a 0.40% increase in the value of imports.	***A 1% increase in supply will lead to a 0.40% increase in the value of imports.
lndemandm	***A 1% increase in demand will lead to a 0.74% increase in the value of imports.	***A 1% increase in demand will lead to a 0.82% increase in the value of imports.	***A 1% increase in demand will lead to a 0.82% increase in the value of imports.
lnlpi	A 1% increase in the average LPI score will lead to a 0.01% increase in the value of imports.	A 1% increase in the average LPI score will lead to a 0.28% increase in the value of imports.	A 1% increase in the average LPI score will lead to a 0.28% increase in the value of imports.
exchange	**When the importing country's currency is stronger than the exporting country's currency, the value of imports will be 11.07% higher than elsewise.	***When the importing country's currency is stronger than the exporting country's currency, the value of imports will be 14.11% higher than elsewise.	**When the importing country's currency is stronger than the exporting country's currency, the value of imports will be 14.11% higher than elsewise.
pland	***When an exporting country is landlocked, the value of imports is 69.97% lower than if the exporting country was not landlocked.		
colang	If the importing and exporting country share a common official language, import value will be 29.05% higher than if they did not share one.		
contig	***If the importing and exporting country share a common border, import value will be 647.07% higher than if they were not contiguous.		
crec	***Mutual membership of a REC increases imports by 452.90% compared to if		

Variable	Poisson RE	Poisson FE	PPML FE
	the trading partners do not have a common REC membership.		

*** p<0.01, ** p<0.05, * p<0.1

6.5. Discussion

The FE PPML model was selected as the model of choice for further discussion, as its results were the most realistic and it has the most benefits as an estimation in this case, considering its ability to deal with heteroscedasticity and zero trade flows – these benefits were discussed in Chapter 4.

The positive sign and high significance of the supply variable (total exports of agricultural goods by the exporting country) shows that the larger the level of production and available supply of agricultural goods the more trade will take place between two African countries. The positive sign and high significance of the demand variable (total imports of agricultural goods by the importing country) means that the larger the demand for agricultural goods in an African country the larger the level of imports is likely to be. Demand can be affected by consumer preferences, a growing population and by urbanisation. The positive sign and high significance of the exchange rate dummy variables indicates that price competitiveness plays a role in determining bilateral trade flows of agricultural goods in Africa. Essentially importers will look to purchase goods from countries that are cheaper to buy from, thus indicating that pricing is a consideration for importers of agricultural goods in Africa.

The variable that was of most interest for addressing the study's main research objective of determining the influence of trade logistics quality on intra-African trade of agricultural goods, was of course the LPI variable. The coefficient for the LPI variable is positive which matches the prediction that was made in Table 5-2. However, the LPI variable was not statistically significant at the 10% level. The positive sign for the LPI variable supports the hypothesis that the higher the quality of the trade logistics in the importing and exporting countries the higher the level of imports will be between those countries but the lack of significance does mean that further work will be required to fully corroborate the hypothesis. The literature covered in Chapter 2, Chapter 3 and Chapter 4 form the main argument for why the hypothesis is correct by pointing to the fact that the improved quality of trade logistics would have a positive influence on trade between countries. Amongst others, Limão and Venables (2001), Martinez-Zarzosa and Nowak-Lehman (2003), Takele (2019) and Bottasso et al.'s (2018) studies all indicated that improved trade logistics increases exports and in turn imports by trading partners. Some of these studies looked at African trade and some looked at agriculture but none of them specifically covered the intra-African trade of agricultural goods, which is why this study was undertaken.

To further consider the role of trade logistics quality in the intra-African trade of agricultural goods, it is worth looking at a correlation table (Table 6-5) for the data used in the model as well as a scatter plot (Figure 6-1) of the correlation between import value and the average LPI scores of trading partner countries. The objective of producing scatter plots and a correlation table is to attain an indication of the correlation between variables in order to correctly specify the

mathematical model. Typically, scatter plots will be produced for the independent variables that the author believes will have the most significant impact on the dependent variable – scatter plots for the traditional gravity variables of distance, supply and demand can be seen in Figure 9-1, Figure 9-2 and Figure 9-3 in the Appendix. These relationships can be inexact, as two-way scatter plot graphs and the correlation table do not take into account the nature of panel data which means that the coefficient signs will not necessarily align with those of the Poisson or PPML estimates. In the correlation table it is only the first column that is of real interest *(*Table 6-5*)*. The closer the correlation is to 1, the closer it is to being perfectly linearly correlated. A positive correlation indicates that as the one variable increases so does the other variable and vice versa. A negative correlation indicates that as one variable increases so the other variable decreases. From the correlation table, one can see that the natural log of distance has a negative relationship with imports but the natural logs of supply, demand, and average LPI are positively related to imports. These correlations are as expected, based on the basic intuition of the gravity model and support the concept the trade logistics quality of African countries is positively linked to the value of trade in agricultural goods between those countries.

Table 6-5 Correlations

	importst	lndist	lnsupp~m	lndema~m	lnlpi
importst	**1.0000**				
lndist	**-0.1238**	**1.0000**			
lnsupplym	**0.1628**	**0.1158**	**1.0000**		
lndemandm	**0.0565**	**0.1645**	**-0.0946**	**1.0000**	
lnlpi	**0.1751**	**0.1543**	**0.2874**	**0.2367**	**1.0000**

In Figure 6-1, one can observe the positive correlation between the natural log of the average LPI score and the value of imports, which is the same as that of the correlation table (Table 6-5). In the Appendix, separate scatter plots were produced for the natural log of the exporter's LPI and the value of trade (Figure 9-4), as well as the natural log of the importer's LPI and the value of trade (Figure 9-5). Both of those scatter plots also indicate a positive correlation between trade logistics quality and the value of agricultural imports.

Although the scatter plot graphs are not specific in terms of the magnitude of the association between the value of imports and the key independent variables, they do still provide enough information for one to gauge whether the relationships in this dataset are aligned with literature on the topic. The literature and the positive correlation between trade logistics quality and imports (Table 6-5 and Figure 6-1) would lead one to expect that the average LPI variable would have been significant in the gravity models that were run for this study. However, the average LPI variable despite having the expected sign was not significant at the 10% level (Table 6-3) so a conversation about the possible reasons for this outcome is required.

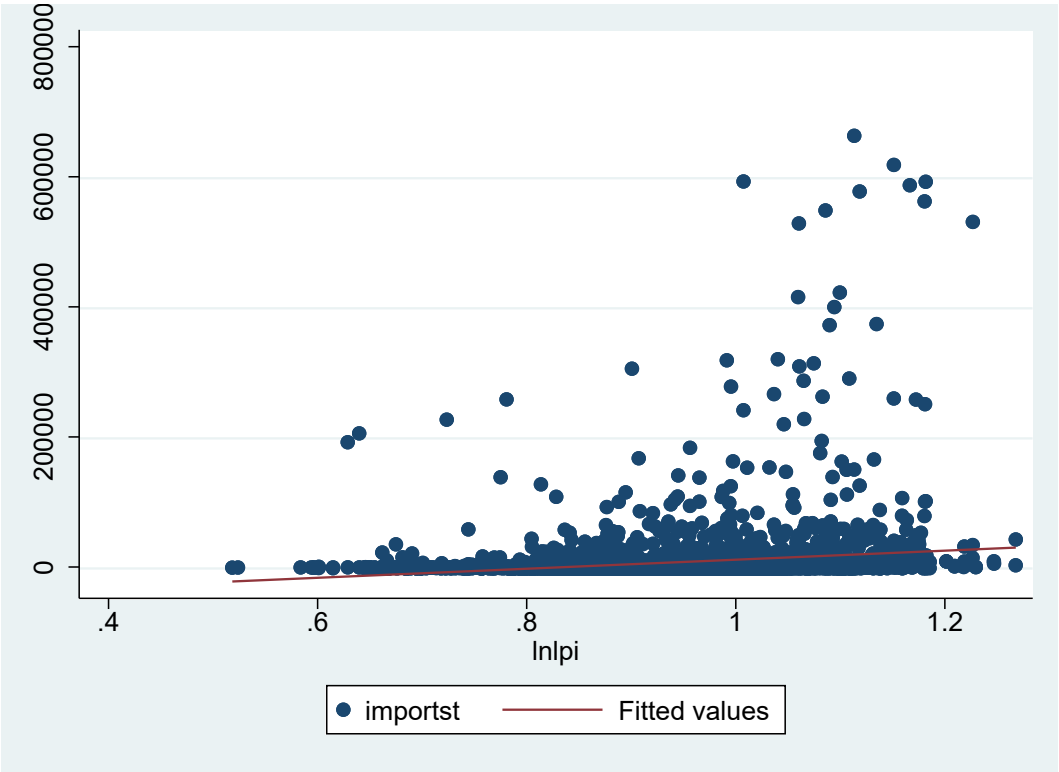


Figure 6-1 Scatter plot of Imports and the natural log of average LPI

Raballand et al. (2012) comment that efficient trade logistics and low-cost transport are necessary for a country's firms to be competitive in the global market but that it will not be enough to guarantee success for exporting firms. In other words, trade logistics quality on its own is not sufficient to influence a country's choice in trading partner. Coşar and Demir (2016) raise the point that the international shipment of goods involves both domestic and international transportation of goods, as well as transhipment across different modes of transport. Unless trade is taking place between neighbouring countries, goods are frequently transported through third party transit countries and the trade logistics quality of these countries will also impact on overall trade (Shepherd, 2016). Shepherd (2016) emphasises that it is not only the home country's trade logistics quality that matters when it comes to connectivity to global value chains but also the trade logistics quality of neighbouring countries. Earlier in this chapter, it is disclosed that in this study's data set, trade with neighbours only took place in 8.53% of the observations and 34.21% of exporters were landlocked which meant that direct trade by maritime transport was not consistently possible. This suggests that a substantial portion of trade that took place included third party transit countries and involved overland transport. In theory, air transport would eliminate transit countries but as was mentioned in Chapter 3, air transport is typically not used for intra-African trade. Even maritime transport sometimes involves transit countries, when a hub port is used to reload shipments due for a smaller port in another country or when goods are offloaded and then transported by rail or road into the hinterland to landlocked importing countries.

The international LPI which was used as a measure of the quality of trade logistics was included for the importing and exporting country in the gravity model but no form of measurement was used for third party transit countries. In this sense the model may have been unable to fully account for the quality of the trade logistics involved in the trade between two given countries. The reason for not including a measure of logistics quality for transit countries was due to the complexity of this metric. To measure the quality of trade logistics across the whole journey of

agricultural goods from one country to another would be difficult considering the multiple options of both transport modes and routes that could both impact on how the metric would be measured.

It is also possible that having used the international LPI scores in the gravity model, the effects of the domestic trade logistics quality were not completely catered for in the model. The domestic LPI measure is briefly mentioned in Chapter 3 and is something to consider for future iterations of this model.

It is noted in Chapter 1 that not all agricultural goods have the same transport requirements. For example, perishable have different transport requirements to bulk goods and bulk goods have different transport requirements to processed goods. Perishable goods often require cold chain storage, which is more costly than standard transport. Certain categories of agricultural goods are likely to be more sensitive to the quality of trade logistics due to their perishability and/or value. In this study, the model treated agricultural goods as a single entity rather than disaggregating them into types of agricultural goods and this may have contributed to the insignificance of the average LPI variable. In the “Trade Trends” sub section of Chapter 2 it is pointed out that maize is a major agricultural good traded between African countries. Maize is considered a bulk good and the inclusion of maize and other bulk goods in the dataset for the model could have caused the insignificance. It certainly would have been preferable to run the same models for a disaggregation of agricultural goods to see if the trade of different categories of agricultural goods between African countries is impacted similarly by trade logistics quality or not. The main reason this was not undertaken is this study is that the author had concerns about the availability of the African trade data. African trade data is already quite “thinly” available and narrowing the category of agricultural products would have undoubtedly reduced the number of observations and thus the sample size for the model, which could have caused unrealistic results. Nonetheless based on the results of the model this is an avenue that should be considered for further research on the topic.

Another consideration is that the quality of trade logistics in a country is unlikely to change rapidly over a period of a few years. Therefore, the model could potentially be improved by using a dataset that covers a longer time period. The challenge involved with this would be to find a proxy for trade logistics quality that is available consistently over a longer time period. The time period of 2010-2018 is considered in the gravity model. The reason for this limitation was twofold. Firstly, on the basis of practicality, the author wished to keep the data set a manageable size but secondly and more importantly the time period was chosen to align with the data that is available for the LPI – this data is updated every two years by the World Bank. Data for five years (2010, 2012, 2014, 2016 and 2018) is used in the gravity model. The LPI is only available for one additional year, which is 2007, which was not included in the model’s dataset due to the three-year time gap between measurements, which is not congruent with the rest of the time gaps between measurements.

The last possibility considered in relation to the insignificance of the average LPI variable in the PPML FE model is that trade logistics quality only matters up until a certain point. In other words, once a country reaches a baseline of “decent” trade logistics quality then improvements in quality have limited further impact on the levels of trade that take place. The scatter plot (Figure 6-1) illustrates a definite upward trend, as the natural log of LPI increases so the value of trade increases, however noting that the maximum trade value is reached before the maximum LPI score. This trend in the scatter plot supports the idea that beyond a certain LPI score (level of

trade logistics quality) little or no increase in trade will be generated due to improvements in trade logistics quality. Along the same thought process, it is possible that below a certain quality threshold a deterioration in trade logistics quality may also have no impact on trade levels.

6.6. Conclusion

The chapter first looked at the composition of the dataset. In more than a quarter of the observations, the exporting country was landlocked. The distance between trading partners varied from 105 km to 9097 km. Other descriptive statistics were also mentioned in this sub-section. These descriptive statistics were all provided to give context to the dataset and the results that followed.

The results of the Poisson and PPML estimations were included in the third sub-section. The key takeaways from the PPML FE estimation were that:

- The estimated coefficients for the natural log of supply and demand had the expected signs and were of high significance, which lent credibility to the estimations of the other variables in the gravity equation.
- Of the four independent variables, two of them were statistically significant at the 1% level, one independent variable, the dummy for exchange rate, was significant at the 5% level and only average LPI was found to be insignificant at the 10% level, despite its positive sign which aligned with the prediction made in Chapter 5.
- All of the significant variables' coefficient signs matched the predictions that were made in Chapter 5.

The hypothesis was partially supported by the model output, as the LPI variable had the anticipated positive sign but further work will be required to fully support the hypothesis. For this reason, a discussion was presented around the possible reasons for unexpected insignificance of the average LPI variable. It is possible that the quality of the trade logistics of the countries involved isn't as a large an influence as other factors that determine where firms decided to import from, which aligns with the comments of Raballand et al. (2012) that good quality trade logistics is not enough to be competitive and secure exporting success. Another likely reason is the possibility that this particular model was possibly unable to adequately capture the impact of trade logistics on trade due to the exclusion of the trade logistics quality of third-party transit countries in the data set and gravity equation. Other concerns include the short time period of the dataset and the choice to keep agricultural goods aggregated in the model. These thoughts lead into suggestions for further research which are covered in the next chapter. It is clear that more evidence and therefore more research will be required to substantiate the hypothesis of this study.

7. Conclusion

7.1. Introduction

Chapter 1 provided context, set the scene with a relatively comprehensive background and gave an outline of the proposed method as well as a roadmap for the study. Chapter 2 went on to give a brief overview of international trade theory before listing the benefits of regional integration and intra-regional trade. The chapter then gave context to trade on the African continent by discussing the existing regional economic communities, and illustrating intra-African trade patterns. Chapter 2 also discussed the unique features of agricultural trade and closed out by outlining the factors that, according to literature, have an influence on trade. Chapter 3 spoke about the role that trade logistics plays in the export supply chain, which was then contextualized by reviewing the current state of African trade logistics and its various components. The last sub-section of Chapter 3 discussed three different measurements of trade logistics quality and the current ratings of each for African countries. This was an important section as one of these measures was selected as a variable for this study's gravity model. Chapters 2 and 3 were written to provide an understanding of the overall topic and to show how trade logistics fits in the current state of African trade. Chapter 4 provided a theoretical overview of gravity models, their applications and the various methods for estimation that can be used. Chapter 5 was centred around the practical application of a gravity model to this study. The chapter covered the design, implementation and specification of this study's gravity model. Chapter 6 gave a summary of the results of the econometric analysis and discussed reasons for why the results reflected as they did. Chapter 7 will conclude the study by summarising the findings of both the literature review and the model, before considering the practical implications there-of that lead to policy recommendations and suggestions for further research.

7.2. Summary of Findings

The review of literature in the earlier chapters made a couple things very clear. African countries are not fulfilling their potential for trade and regional trade agreements are currently uncoordinated, although with the development of the AfCFTA this may change. Overland transit delays in Africa are hugely inhibiting to trade, especially for the landlocked countries which make up one third of African countries. Railroad and road transport are the two key enablers of overland transportation of goods. Roads across Africa are generally low in density and in a state of disrepair and a large percentage of existing railway networks are slow or non-operational. There is a growing interest in investing in regional trade corridors by RECs, which can at least solve this problem in pockets but widespread investment and maintenance projects will be required to properly connect Africa over land. Many studies including Bottasso et al (2018), Marti et al. (2014), Takele (2019), Bensassi et al. (2015), Portugal-Perez and Wilson (2012), Freund and Rocha (2010) and others have found evidence that the quality of trade logistics impacts trade.

This links into the results of the gravity model; the average LPI variable's coefficient was positive but insignificant at the 10% level. In the models' outputs, the estimated coefficients for distance, supply and demand had the expected signs and are of significance at the 1% level, which lends credibility to the estimations of the other variables in the gravity equation. Distance, supported by

a substantial literature base, proved to have a negative relationship with imports according to the gravity model. Conversely the proxies for supply and demand both had positive relationships with trade, thus meeting the intuitive expectations of the gravity model. The dummy for common official language was found to be insignificant and although it probably remains important for the ease of doing business and thus the increased likelihood of firms in two different African countries trading with each other. RECs and their relevant trade agreements continue to be a factor for intra-African trade. This statement is supported by both the gravity model and accompanying literature in Chapter 2. The significance of the contiguity dummy in the model further evidenced the statements made in Chapter 2 that African countries first and foremost prefer to trade with their neighbours. Being landlocked definitely plays a role from the perspective of firms in the exporting country as it increases costs and reduces their ability to compete with firms in other countries that have direct access to seaports. Pricing is of importance for the importing country and this was illustrated in the gravity model by the significance of the exchange dummy variable. The exchange dummy variable indicated that a country is more likely to import from a country that has a weaker currency than its own, over a country that has a stronger currency than its own.

7.3. Practical Implications

The gravity model showed that distance, supply and demand all influence trade of agricultural goods amongst African countries. However, these variables are not particularly malleable, when it comes to policy. Distance simply cannot be changed, at least not in straight line terms – at most, more direct roads and railways can be built or direct flight routes can be introduced but this is not the obvious or most cost-effective way to try and increase trade. From a demand perspective there is not much than can be done either, but in terms of supply governments can look at introducing producer subsidies for their farmers. Producer subsidies are not a topic that has been covered by this study so no detailed recommendations will be given regarding this point. In terms of the other variables used in the gravity model, there are a couple that similar to distance are difficult or impossible to change. Whether a country is landlocked or not, cannot be changed by policy but it is possible that with the introduction of AfCFTA it may become cheaper for landlocked countries to access ports in neighbouring countries. In terms of sharing a common official language, this is another piece of information that although useful cannot be leveraged quickly or easily. The strength of a country's currency is also not easily controllable and although macro-economic strategies can be employed to try and build currency strength there are outside factors that influence the strength of a country's currency.

The only variables included in the gravity model that can actually be influenced by changes in policy is the common membership of RECs and the LPI scores of importing and exporting countries. There are already efforts to align free trade agreements in Africa and to improve on and eventually replace the existing RECs through the continued planned implementation of the AfCFTA so no specific recommendations will be given relating to the membership of RECs. The gravity model was unable to provide exact evidence that the quality of trade logistics positively influences intra-African trade of agricultural goods. However, based on the literature review, there is evidence that the intra-African trade of agricultural goods can be stimulated by African countries through investment in components of their trade logistics. This could include improved customs administrator training, the building of railway networks, or even the simplification of cross border documentation processes through increased use of digital systems. There is also an indication from other studies that regional integration and joint projects involving trade corridors could further

open up trade within the continent. Korinek and Sourdin (2011) have previously highlighted the importance of promoting policies that drive trade facilitation reforms forward and this study suggests the same, particularly with regard to overland transport and trade.

7.4. Policy and Research Recommendations

This study did not explore the importance of logistics quality in transit countries or capture their effects in the gravity model. Transit countries are most prevalent when transport of goods is taking place overland and overland transport has its own set of unique challenges including multiple border crossings. Reference was made to this issue in Chapter 3, when the difficulties of road conditions were discussed for an overland trip from South Africa to Nigeria. Taking the African context into mind, the quality of trade logistics in transit countries could play a key role in determining trade, at least for overland transportation. Finding a way to quantify this 'in-between' trade logistics quality, would then allow governments to make better policy decisions regarding regional economic communities and trade corridors. Establishing how to comprehensively incorporate trade logistics quality for transit countries into a gravity model could be considered as a topic for future research.

Looking at the role of transit countries in the overland transport and trade of agricultural goods in Africa, it becomes apparent that trade corridors are strategically important. From a policy perspective, the first recommendation is for African governments to consider how existing trade corridors can be bolstered through investments and to identify where joint ventures with other states could lead to new trade corridors. In essence, transport corridors are a public good. They are controlled by the governments of the countries through which they pass. The main purpose of a transport corridor is to generate new trade opportunities and to heighten competitiveness. There are network effects with trade corridors, which means that a certain number of users are required in order to reduce the costs for all users of the corridor. Essentially scaled usage is key to successful trade corridor project. If there are not enough users then investment into a trade corridor can become an expensive regret, as the costs of using and maintaining it end up costing users. All the countries involved need to be in agreement for it to be a sustainable solution.

Another research possibility stems from the fact that the quality of trade logistics doesn't change rapidly enough for improvements to be seen in imports over a 10-year time period. The suggestion based on this would be to repeat this study's model for a longer time period of a minimum of 20 years. The reason this was not done in this first iteration of the model is that the LPI does not extend far enough back in time to create such a dataset. One would have to find a different proxy for the quality of trade logistics to use instead of the LPI, if one wanted a dataset that covered 20 years

This study could also be changed to rather explore the influence of specific components of trade logistics on the intra-African trade of agricultural goods. One could look specifically at a type of infrastructure such as seaports or one could investigate some elements of the customs environment such as documentary requirements. This could be done using a different unit of measurement such as the Global Competitiveness Index which is mentioned in Chapter 4. A similar suggestion would be to replicate this study but using more disaggregated data in terms of agricultural goods by splitting them into three or more sub-categories that are perceived to have different levels of sensitivity to trade logistics quality.

In Chapter 4, the inefficiency of African seaports is discussed and the literature strongly suggests that poor management of facilities is one of the major issues. In terms of policy there is reference to rent seeking behaviour and a lack of sufficient incentive for ports to be run efficiently. There may be some opportunity for the privatisation of seaports on the continent, although this is not a popular strategy.

The last research recommendation would be to build on the concept of this study and to explore whether an improved transport, freight and logistics ecosystem can unlock further potential in African agriculture. An improved transport, freight and logistics ecosystem would encompass infrastructure expansion and maintenance, logistics performance as well as systems integration. An idea would be to look at the domestic effects of an improved transport freight and logistics ecosystem in terms of creating greater efficiencies to drive the primary agriculture and agro-processing sectors.

7.5. Conclusion

The study concludes with partially successful results. Following the literary and theoretical unpacking as described in the introduction of this chapter, the gravity model estimation showed a positive relationship between trade logistics quality and the value of trade of agricultural goods between African countries, albeit insignificant at the 10% level. The model re-affirmed the intuitive underpinnings of the gravity model and the results raised probing questions around how the model could be improved and/or what further research can be done to substantiate the findings of this study.

The ultimate aim of the study was to prove that the trade logistics quality of importing and exporting countries positively influences the intra-African trade of agricultural goods. The gravity model was only able to partially support this hypothesis. However, the literature review fully supported the hypothesis and provided additional credibility to the notion that improved trade logistics quality can stimulate the intra-African trade of agricultural goods. This inspired the author to generate policy recommendations and ideas for further research that can build on this study's findings.

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9. Appendix

9.1. Tables

Expenditure elasticity is the percentage change in money spent on a certain group of goods or services as total spending increases (Browne et al. 2007). A positive elasticity indicates that as expenditure increases so does the proportion of spending on that group. If the elasticity is positive and greater than 1 then it indicates that expenditure on that group will increase at a faster rate than overall expenditure.

Table 9-1 Elasticities by Food Category in East and Southern Africa

Expenditure Elasticities by Food Category, Rural and Urban (East and Southern Africa)			
Purchased Food Category	**Rural**	**Urban**	**East and Southern Africa Wide**
Non perishable			
Unprocessed	0.75	0.51	0.69
Processed Low Value Added	0.79	0.61	0.75
Processed High Value Added	1.07	1.00	1.05
Perishable			
Unprocessed	0.78	0.73	0.77
Processed Low Value Added	1.14	1.07	1.12
Processed High Value Added	1.54	1.38	1.50

Source: Tschirley et al. (2015)

Table 9-2 shows which countries were included in the data sample used in this study's gravity model.

Table 9-2 African Countries included in the Study Sample

Countries Included in the Sample for this Study		
Algeria	Ghana	Rwanda
Angola	Ivory Coast	Sao Tome and Principe
Benin	Kenya	Senegal
Botswana	Lesotho	Somalia
Burkina Faso	Madagascar	South Africa
Burundi	Malawi	Tanzania
Cameroon	Mauritania	The Gambia
Central African Republic	Mauritius	Togo
Chad	Morocco	Tunisia
Democratic Republic of Congo	Mozambique	Uganda
Egypt	Namibia	Zambia
Equatorial Guinea	Niger	Zimbabwe
Ethiopia	Nigeria	

Table 9-3 shows which goods were included in the data sample used in this study's gravity model.

Table 9-3 HS Chapters Defined as Agricultural Goods

Agricultural Goods	
HS Code Level 2	**Description**
02	Meat and edible offal
04	Dairy produce; birds' eggs; natural honey; edible products of animal origin not elsewhere specified or mentioned
07	Edible vegetables and certain roots and tubers
08	Edible fruit and nuts, peel of citrus fruits or melon
09	Coffee, tea, mate and spices
10	Cereals
11	Products of the milling industry; malt; starches; inulin; wheat; gluten
12	Oil seeds and oleaginous miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder
17	Sugar and sugar confectionary
18	Cocoa and cocoa preparations
19	Preparations of cereals, flour, starch or milk; pastrycooks products
20	Preparations of vegetables, fruits, nuts or other parts of plants
21	Miscellaneous edible preparations
22	Beverages, spirits and vinegars

Table 9-4 Results for GDP PPML FE Model

VARIABLES	PPML_FE importst	
	Coefficient	**P>|z|**
lnpGDPm	0.045	0.721
	(0.125)	
lnrGDPm	0.596***	0.007
	(0.222)	
lnlpi	0.222	0.573
	(0.393)	
exchange	0.070	0.409
	(0.085)	
Observations	3933	
R-squared	0.941	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9-4 shows the PPML FE results when, unlike the main model in Chapter 6, GDPs are used instead of total agricultural exports and total agricultural imports as proxies for supply and demand. The main difference between the two PPML FE models is the significance of the variables' coefficients. When GDP is used as a proxy for supply and demand, only one variable is highly significant. The GDP of the importer is significant at the 1% level but the other variables are all insignificant at the 10% level, although all four variables have the signs that would have been predicted for their coefficients.

9.2. Figures

Graphical techniques such as scatterplots can be used to test the basic underlying intuition of the gravity model.

The correlation between the import value and the natural log of the distance between the exporter and importer is slightly negative, when looking at the line of best fit, which confirms the information that was provided in the correlation table (Table 6-5, Figure 9-1).

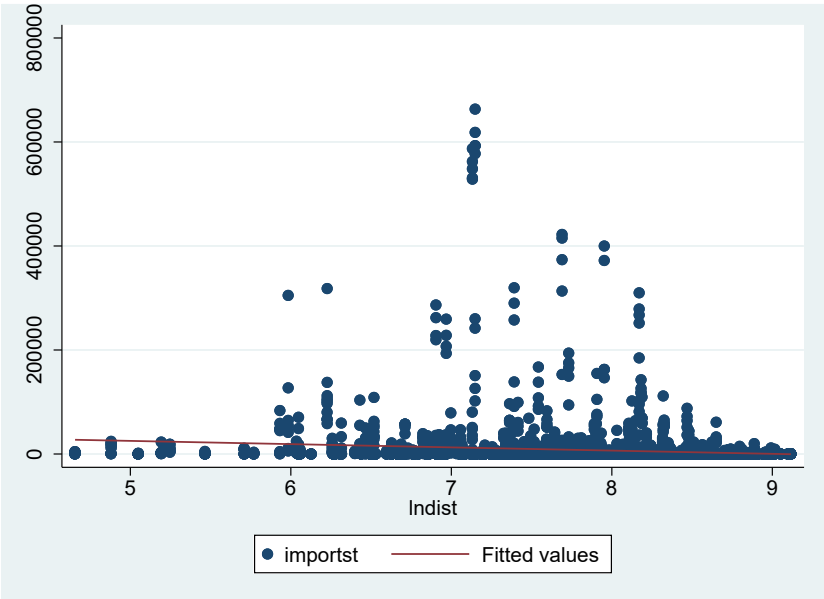

Figure 9-1 Scatter plot of Imports (USD thousands) and the natural log of Distance between the Exporter and Importer

The line of best fit indicates that there is a positive relationship between the value of imports and the natural log of the demand of the importing country (Figure 9-2).

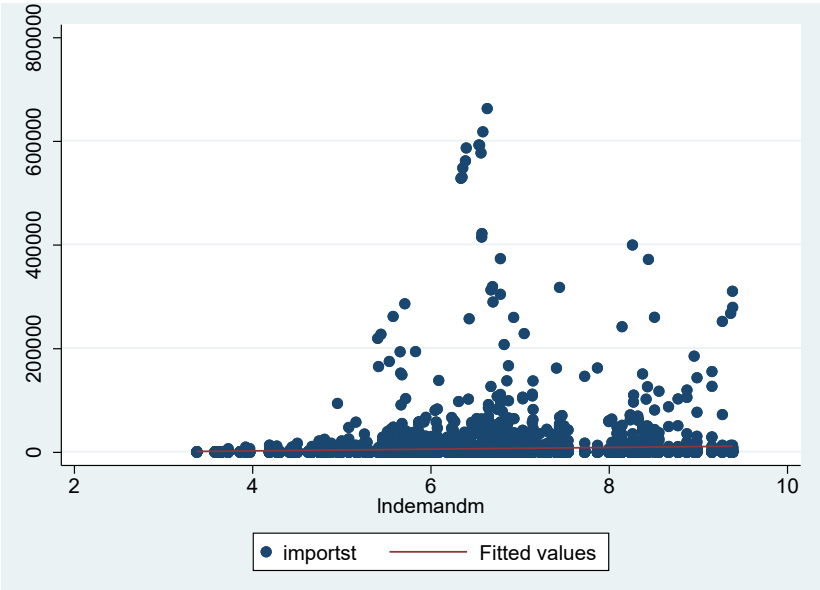

Figure 9-2 Scatter plot of Imports (USD thousands) and the natural log of the Demand of the Importer

The line of best fit indicates that there is a positive relationship between the value of imports and the natural log of the supply of the exporting country (Figure 9-3).

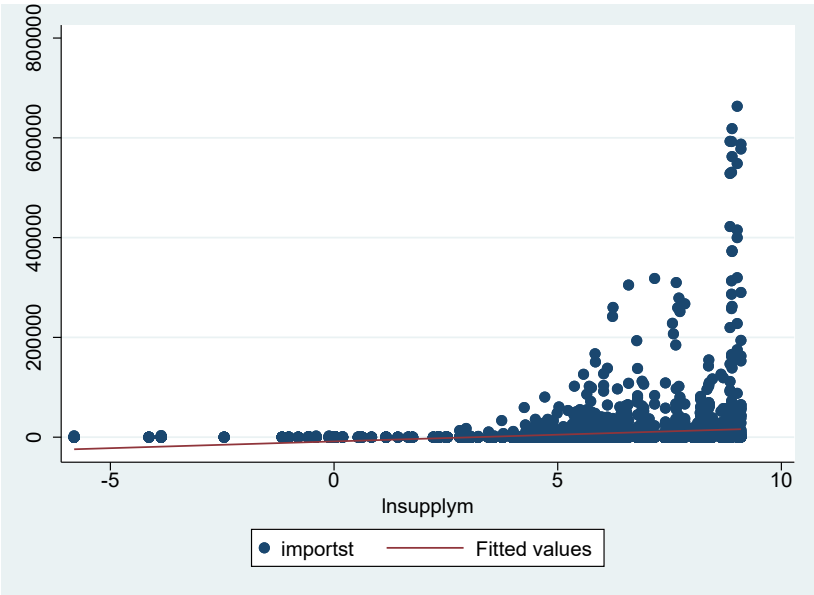

Figure 9-3 Scatter plot of Imports (USD thousands) and the natural log of the Supply of the Exporter

Although the scatter plot graphs are not specific in terms of the magnitude of the association between the value of imports and the key independent variables, they do still provide enough information for one to gauge whether the relationships in this dataset are aligned with literature on the topic The negative correlation with distance and the positive correlations with supply and demand meet one's intuitive expectations of trade theory and the gravity model.

The line of best fit indicates that there is a positive relationship between the value of imports and the natural log of the LPI of the exporting country (Figure 9-4).

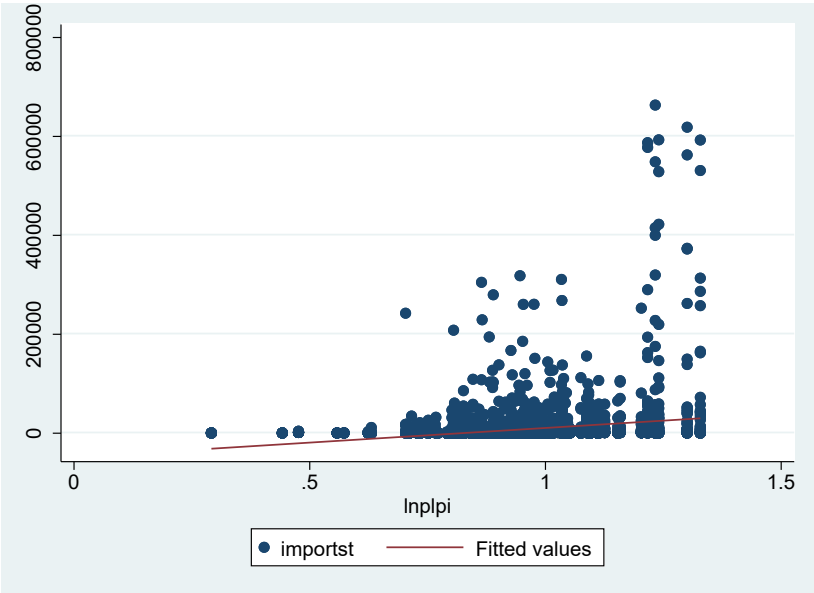

Figure 9-4 Scatter plot of Imports (USD thousands) and the natural log of the Exporter's LPI

The line of best fit indicates that there is a slight positive relationship between the value of imports and the natural log of the LPI of the importing country (Figure 9-5).

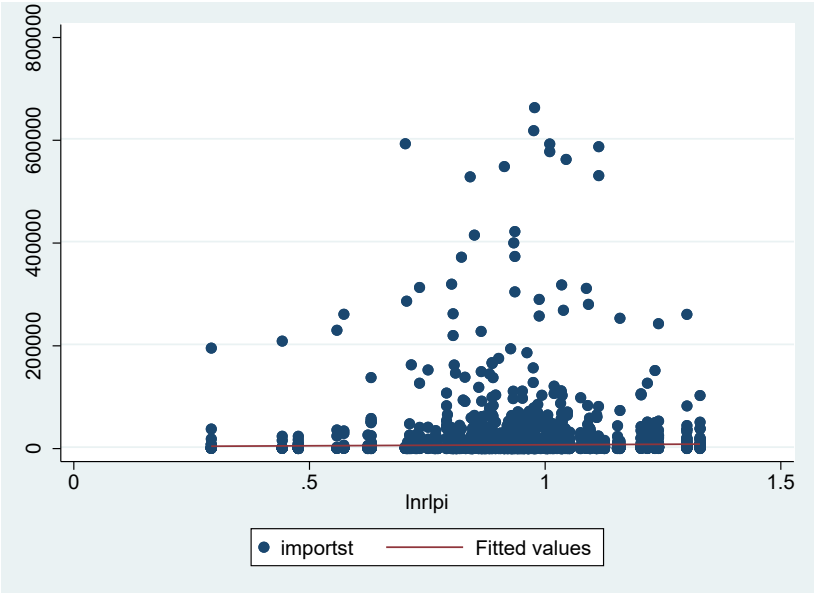

Figure 9-5 Scatter plot of Imports (USD thousands) and the natural log of the Importer's LPI